SAN FRANCISCO PUBLIC LIBRARY
3 1223 06194 7074

## *Francisco Municipal Railway*

# Light Rail Fleet Management Plan

D

June 2001

DOCUMENTS DEPT.
OCT 25 2001
SAN FRANCISCO
PUBLIC LIBRARY

REF
388.4209
W329L

5/S

San Francisco Public Library

GOVERNMENT INFORMATION CENTER
SAN FRANCISCO PUBLIC LIBRARY

REFERENCE BOOK

*Not to be taken from the Library*

# Light Rail Fleet Management Plan

San Francisco Municipal Railway
Michael T. Burns, General Manager

June 2001

*Prepared by Duncan Watry and Anne Richman, Capital Planning & Grants*

# CONTENTS

1. Executive Summary ........ 1
2. Introduction ........ 2
3. Existing System ........ 2
    A. Service Characteristics ........ 2
    B. Vehicles ........ 4
    C. Track and Infrastructure ........ 4
    D. Maintenance Facilities ........ 6
4. Expansion Plans ........ 7
    A. Capacity Enhancement on Existing System ........ 7
    B. Muni Metro Expansion ........ 8
    C. Historic LRV Expansion ........ 13
    D. Metro East Maintenance Facility ........ 14
5. Demand for Revenue Vehicles ........ 17
    A. Running Times ........ 17
    B. Ridership ........ 17
    C. Load Factors ........ 17
    D. Peak Vehicle Demand ........ 22
6. Supply of Revenue Vehicles ........ 28
    A. Current Fleet ........ 28
    B. Future Vehicle Purchases ........ 29
7. LRV Fleet Plan ........ 29
8. Maintenance and Reliability ........ 34
    A. Vehicle Problems ........ 34
    B. Car Availability ........ 34
    C. Mean Distance Between Failures ........ 34
    D. Holds ........ 39
    E. Overhaul Programs ........ 39
    F. Revenue Vehicle Demand/Supply Balance ........ 39
9. Conclusion ........ 40

Appendix A – System Map ........ 44
Appendix B – LRV Fleet Roster ........ 45
Appendix C – HSC Fleet Roster ........ 46
Acknowledgments ........ 47

# FIGURES

Figure 1 Current Light Rail Lines ... 2
Figure 2 Service Characteristics ... 3
Figure 3 Light Rail Operating Environments ... 4
Figure 4 Track Mileage ... 5
Figure 5 LRV Facilities ... 6
Figure 6 Third Street Light Rail Project ... 10
Figure 7 Projected Operating Statistics ... 11
Figure 8 3rd Street Light Rail Project Schedule ... 12
Figure 9 Fleet Storage Assignments ... 16
Figure 10 Weekday Running Times ... 18
Figure 11 Annual LRV Ridership ... 19
Figure 12 Average Weekday Ridership ... 20
Figure 13 Load Factors ... 21
Figure 14 Peak Vehicle Demand ... 22
Figure 15 Hourly Equipment Demand (Weekday) ... 23
Figure 16 Hourly Equipment Demand (Saturday) ... 24
Figure 17 Hourly Equipment Demand (Sunday) ... 25
Figure 18 Planned Service Changes ... 26
Figure 19 Peak Vehicle Demand ... 27
Figure 20 LRV Ridership Projections ... 31
Figure 21 LRV Fleet Composition ... 32
Figure 22 HSC Fleet Composition ... 33
Figure 23 LRV Availability ... 35
Figure 24 PCC Availability ... 35
Figure 25 Mean Distance Between Failures ... 36
Figure 26 30-Day LRV Holds – Weekday AM Peak ... 37
Figure 27 30-Day Hold Items ... 38
Figure 28 Breda LRV-2/3 Overhaul Needs ... 39
Figure 29 LRV Overhaul Schedule ... 41
Figure 30 HSC Overhaul Schedule ... 42
Figure 31 Revenue Vehicle Demand/Supply Balance ... 43

3 1223 06194 7074

SAN FRANCISCO MUNICIPAL RAILWAY
1145 MARKET STREET, 3RD FLOOR, SAN FRANCISCO, CA 94103-1547
(415) 934-3954 FAX (415) 934-3930

October 18, 2001

All Interested Parties:

Attached for your information is Muni's new **Light Rail Fleet Management Plan**. This document was produced to comply with Federal requirements, and is used as a primary input to the Fleet Plan portion of the FY2001/02 update of the Short Range Transit Plan (SRTP) and the Capital Improvement Program (CIP). This document describes Muni's current light rail fleet, facilities, operations, and maintenance activities. It also describes anticipated changes in Muni's light rail system, including planned service changes, changes in demand for vehicles, changing fleet composition, and changes anticipated in ridership. This fleet plan documents that Muni has the capability to manage the current light rail operations with an acceptable level of spare vehicles, and that Muni is prepared for the changes coming in the next few years.

This document is being distributed as Muni is moving into construction on the Third Street Light Rail Project Phase 1 (Initial Operating Segment), and the new Metro East Light Rail Facility. The procurement of Breda LRV cars to replace the final Boeing SLRVs continues, as well as procurement of the additional cars needed to operate the Third Street project. In addition, Muni is beginning conceptual engineering work on the Third Street Light Rail Project Phase 2 (New Central Subway), making this an exciting time of renewal and growth for the Muni light rail system.

If you have any comments, corrections, or suggestions for future updates of this plan, please call Duncan Watry at (415) 934-3937 (email duncan_watry@ci.sf.ca.us). If you would like to order additional copies of this plan, please call (415) 934-3954. Thank you for your interest in Muni's light rail operation.

Sincerely,

Walter C. Streeter

Walter C. Streeter

Deputy General Manager
Capital Planning & Legislative Affairs

# 1. Executive Summary

The San Francisco Municipal Railway (Muni) operates a light rail system consisting of five modern light rail lines, known as the Muni Metro, and one historic streetcar (HSC) line (F-Market). Muni's fleet consists of light rail vehicles (LRVs) from two manufacturers, and a variety of historic streetcars and PCC cars from a number of manufacturers. Over the next few years, Muni will accept delivery of additional LRVs from Breda, which will allow the retirement of the last Boeing LRVs.

Muni is expanding light rail service, with construction scheduled to begin in 2001 on the first phase (IOS – Initial Operating Segment) of the Third Street Light Rail Line, which will bring light rail service to the eastern side of San Francisco, serving Bayview and Hunter's Point, and terminating in Visitacion Valley. The second phase of this project will build the New Central Subway, which will extend the Third Street line into the Union Square and Chinatown areas. An integral component of this project is the construction of the Metro East light rail maintenance facility, which will be Muni's second LRV facility. This facility will bring much-needed relief to the extremely overcrowded conditions at the current Green/Geneva facility. Muni has modest plans for increasing the size of the LRV and HSC fleets to accommodate future extensions and service expansions to accommodate future ridership growth, and to enhance capacity on the existing system.

Muni has experienced challenges over the last few years in operating the Metro system, most notably with the simultaneous initiation of several operational changes on the Metro system in August 1998. However, service has returned to pre-1998 levels, and ridership has increased significantly. FY99-00 shows a 17% ridership gain over the previous year, which is a substantial increase for Muni. Muni continues to have very high load factors for the industry.

The Vehicle Demand/Supply Balance calculation for this plan shows that Muni's planned fleet is appropriately sized for the anticipated demands on the system, assuming that the additional vehicles identified in this plan that are needed for Mission Bay ridership expansion and for capacity enhancement on the existing system are acquired.

Muni continues to work to improve maintenance of the LRV and HSC fleets. Muni's Mean Distance Between Failure (MDBF) rate continues to be low for the industry, but this is expected to improve as the remainder of the Breda fleet is delivered and the last of the Boeing cars are retired. This plan proposes a regular program of LRV overhauls, which would help Muni maintain the LRV fleet in good working order throughout the life of the vehicle.

Since the last Rail Fleet Management Plan was published (Draft only – March 1999), Muni has made significant strides in the management and maintenance of the current fleet, planning for future fleet activities, and in moving forward with thoughtful, well-planned expansion. Muni looks forward to reporting similar progress in the future.

## 2. Introduction

The San Francisco Municipal Railway (Muni) operates a multi-modal transit system, largely within the City and County of San Francisco. Muni operates four basic modes; light rail vehicles (LRV), cable car (CC), electric trolley coach (TC), and motor coach (MC). Within each mode, there are a variety of vehicle types, making Muni one of the most diverse transit operators in the country. In the light rail mode, Muni operates modern light rail vehicles (LRV) and historic streetcars (HSC). The HSC fleet includes PCC cars, and a wide variety of vintage cars.

This plan documents the existing system and current condition of the rail fleet (LRV and HSC). It also defines Muni's rail expansion plans, documents the current and projected demand for peak vehicles, and documents the current and projected spare ratio and vehicle supply/demand balance.

Muni's light rail system is currently in transition, with new vehicles arriving on the property, expansion plans approaching the construction phase, and with a multitude of changes planned in the next few years. It is a time of challenges for Muni's light rail system, but also a time for improvement.

Please note that this Rail Fleet Management Plan does not include the cable car system. The cable car system is a unique operation in the United States, and the fleet management plan for the cable car system is covered in the Cable Car System Capital Plan, last issued November 30, 1998.

## 3. Existing System

### A. Service Characteristics

The San Francisco Municipal Railway operates six light rail lines, with two different basic vehicle types (see Figure 1). The current service characteristics of the six lines are shown in Figure 2. Appendix A is a map of Muni's current rail system.

**Figure 1 Current Light Rail Lines**

| Line | Vehicle Type |
|---|---|
| F-Market | PCC/Historic Streetcar (HSC) |
| J-Church | LRV |
| K-Ingleside | LRV |
| L-Taraval | LRV |
| M-Ocean View | LRV |
| N-Judah | LRV |

The F-Market line is a traditional streetcar line, operated with PCCs and HSCs. It was opened in September 1995, and replaced a trolleycoach line on approximately the same alignment. The

### Figure 2 - Service Characteristics

June 2000

| | Weekday | | AM Peak (6-9am) | | | Midday (9am-4pm) | | | PM Peak (4-7pm) | | | Evening (9pm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line | First trip | OB Last trip | Head way | Cars/ Train | Cars/ Hour | Head way | Cars/ Train | Cars/ Hour | Head way | Cars/ Train | Cars/ Hour | Head way | Cars/ Train | Cars/ Hour | PM Peak Demand | Terminals |
| **PCC/Historic Streetcar** | | | | | | | | | | | | | | | | |
| F | 5:08am | 1:16am | 6 | 1 | 10 | 8 | 1 | 8 | 7 | 1 | 9 | 15 | 1 | 4 | 17 | Outer - 17th St & Market<br>Inner - Jones & Beach |
| **LRV - Muni Metro** | | | | | | | | | | | | | | | | |
| J | 4:04am | 12:17am | 8 | 1 | 8 | 10 | 1 | 6 | 8 | 1 | 8 | 20 | 1 | 3 | 11 | Outer - Balboa Park BART<br>Inner - Embarcadero Station |
| K | 4:07am | 12:12am | 8 | 1 | 8 | 10 | 1 | 6 | 9 | 1 | 7 | 15 | 1 | 4 | 11 | Outer - Balboa Park BART<br>Inner - Embarcadero Station |
| L | 4:56am | 11:54pm | 7 | 2 | 17 | 10 | 1 | 6 | 7 | 2 | 17 | 15 | 1 | 4 | 26 | Outer - 46th Ave & Wawona<br>Inner - Embarcadero Station |
| M | 4:59am | 11:49pm | 8 | 2 | 15 | 10 | 2 | 12 | 9 | 2 | 13 | 20 | 1 | 3 | 22 | Outer - Balboa Park BART<br>Inner - Embarcadero Station |
| N | 5:27am | 11:41pm | 7 | 2 | 17 | 10 | 2 | 12 | 6 | 2 | 20 | 12 | 2 | 10 | 34 | Outer - Judah & La Playa<br>Inner - 4th St & King Station |
| **LRV - Muni Metro Subtotal** | | | | | 64 | | | 42 | | | 64 | | | 24 | 104 | |
| **TOTAL** | | | | | | | | | | | | | | | 121 | |

*Source: Muni Schedules Dept. Rotations for June 2000*

J, K, L, M, and N-lines are modern LRV lines, but operate in a mixture of operating environments that have resulted from incremental upgrades to what was formerly a traditional streetcar operation. These five lines are collectively known as the Muni Metro. In addition to the regular service provided on the J, K, L, M and N-lines, Muni also operates a significant amount of additional service to Pacific Bell Park for baseball games.

## B. Vehicles

Muni's light rail fleet is composed of two basic vehicle types: modern light rail vehicles (LRV), and Historic Streetcars (HSC). Within each type there are several variations. The LRV fleet consists of Boeing Standard Light Rail Vehicles (SLRV), manufactured in 1978 and 1983, Breda LRV-2s, manufactured in 1996 through 1998, and Breda LRV-3s, which began delivery in 1999 and are still being delivered today. Appendix B is a roster of LRVs in the fleet.

The HSC fleet consists of a multitude of different vehicles from an assortment of manufacturers, cities and eras. The two largest components of the fleet are a group of President's Conference Committee (PCC) cars, manufactured in 1946 and purchased from SEPTA in 1994, and a group of Peter Witt cars from Milan, Italy, which were manufactured in 1928, and purchased in 1998. Appendix C is a roster of the HSCs in the fleet.

## C. Track and Infrastructure

Muni's rail system consists of a combination of modern light rail operating environments and more traditional streetcar configurations (see Figure 3). The surface portions of the five Metro lines operate on alignments that have been in operation starting in 1917, while the Market Street portion of the F-line has had streetcar service in operation almost continuously since 1860. The surface portions of the lines have a variety of types of boarding locations, including traditional center-of-the-street boarding, safety islands, and high-level platform stations.

**Figure 3 Light Rail Operating Environments**

| Line | Operating Environment |
|---|---|
| F-Market | Surface mixed traffic, median |
| J-Church | Subway, surface mixed traffic, private right-of-way, median |
| K-Ingleside | Subway, surface mixed traffic, median |
| L-Taraval | Subway, surface mixed traffic |
| M-Ocean View | Subway, surface mixed traffic, private right-of-way, median |
| N-Judah | Subway, surface mixed traffic, reserved raised right-of-way, median |

The five Metro lines share a common trunk in the Market Street subway, which opened for service in 1979. Three of the lines (K, L and M) also share a common trunk further west in the Twin Peaks Tunnel, which opened in 1918. The subway has 3 entrances in regular use. The J and N-lines operate into the subway from the outer surface portions of the lines via the Duboce Portal. The J-line terminates in the subway in the Muni Metro Turnback facility (MMT), while the N-line exits the subway via the Folsom portal, and continues on the surface along the Muni Metro Extension (MMX) to a terminal at 4th Street & King, at the Caltrain Terminal. The K, L, and M-lines all enter the subway from the surface portions of the lines at West Portal, operate through the Twin Peaks Tunnel into the Market Street subway, and all three lines operate to a terminal in the MMT.

## Figure 4 - Track Mileage

June 2000

| Line/Location | Lines | Single Track Mileage |
|---|---|---|
| **Muni Metro** | | |
| Market Street Subway | JKLMN | 6.00 |
| Twin Peaks Tunnel | KLM | 5.30 |
| J-Church | J | 5.76 |
| K-Ingleside | K | 5.60 |
| L-Taraval | L | 7.00 |
| M-Ocean View | M | 8.00 |
| N-Judah (includes Sunset Tunnel) | N | 9.80 |
| MMX - MMT to 6th Street | N | 3.00 |
| MMT | JKLMN | 1.18 |
| **Muni Metro Subtotal** | | **51.64** |
| **Other** | | |
| F- Market | F | 12.00 |
| Yard & Shop | All | 2.50 |
| E-line Connector Track | Not in service | 0.50 |
| **Other Subtotal** | | **15.00** |
| **TOTAL** | | **66.64** |

*Source: Operations Division Monthly Management Report*

The MMX along the southern portion of the Embarcadero and King Street was opened for service in 1998, and is a modern light rail median right-of-way, with high-level platform stations and signal pre-emption.

The F-Market line also operates in a variety of rights-of-way. The Market Street portion of the line operates in mixed traffic with boarding islands on an alignment that has had streetcar service almost continuously for 140 years. In early 2000, an extension of the F-line was opened from lower Market Street to Fisherman's Wharf, and this extension operates partly in reserved median, and partly in mixed traffic.

Figure 4 shows total track mileage for the system. See Appendix A for a map of Muni's rail system.

## D. Maintenance Facilities

Muni's LRV and PCC/HSC fleets are maintained at Green Division, which is next to Balboa Park BART Station, at the corner of Geneva and San Jose Avenues in San Francisco. This division consists of the Green Light Rail Center (opened in 1979) and the Geneva facility. Some minor repairs on historic cars are also performed at the Mint Division. Muni's current LRV facilities are summarized in Figure 5.

**Figure 5 LRV Facilities**

| Name | Car Types | Major Functions |
|---|---|---|
| Green Light Rail Center | LRV | LRV Operating Division, maintenance, heavy repair |
| Green Annex | | Administrative, crew dispatch, electronic shop |
| Geneva | LRV, HSC | LRV and HSC maintenance, paint shop |
| Upper Yard | HSC | Car storage |
| Mint Division | HSC | Minor repairs |
| Pier 72 | HSC | Inactive car storage |

The Green and Geneva facilities are currently operating beyond their capacity to maintain and store vehicles. The two facilities together were designed to accommodate approximately 130 vehicles. The active LRV and HSC fleets together are now at approximately 170 vehicles (136 LRV + 34 active HSCs). The effect of this is that some vehicles must be parked on city streets at night, due to the fact that the yard is completely full, and the Upper Yard has been returned from use as employee parking to LRV/HSC storage, and may be used for active vehicle dispatching in the near future. The crowded conditions in the yard also make some routine maintenance procedures very time-consuming to perform, as shifting vehicles in and out of shops is often difficult due to the crowded conditions. After approximately 10:00pm each night, the yard is completely full, and movement is not possible until the morning pullouts begin at approximately 4:00am the next morning. In addition, new LRV deliveries are occurring, which requires that additional vehicles be on the property while the new vehicles are accepted and the old vehicles are retired.

Green Center is a complete maintenance facility, with the capability to perform all levels of maintenance and repair on the LRV/HSC fleet. In addition to Running Repair, Preventive Maintenance, Heavy Repair and a Paint and Body Shop, Green Center also contains a Unit Repair Shop, a Radio Repair Shop, Farebox Repair Shop, and Electronics Shop.

# 4. Expansion Plans

Muni has a number of projects underway to expand light rail service, both for the Muni Metro system and for the HSC system. Muni is in the process of developing the San Francisco Transit Expansion and Enhancement Plan, which will establish priorities for expanding rail service. This plan will be published in November 2001.

## A. Capacity Enhancement on Existing System

### 1. Muni Metro

As demonstrated in subsequent sections of this document, in recent years Muni has been experiencing ridership growth on the Muni Metro system, after a period of relatively stable ridership levels. This growth, coupled with traditionally high load factors in the peak periods, indicates that Muni may need to enhance capacity on the existing system. This could be handled in several ways; either by acquiring additional vehicles to run additional trains or longer trains, or by initiating operational changes to the existing system. The L-Taraval and N-Judah lines appear to be most affected, and both of these lines already operate with two-car trains on high frequencies in the peak periods.

### a. Additional Vehicles

In the 1997 edition of Muni's Short Range Transit Plan (SRTP), Muni planned for an increase in fleet size of 23 vehicles to cover both Third Street expansion (19 vehicles projected additional peak demand in 2004) and capacity expansion for Mission Bay (4 vehicles projected additional peak demand in 2005). This analysis assumed that no additional vehicles would be required as spares – that all of the new vehicles acquired would be applied to the new peak demand, and that the existing spare ratio could handle the maintenance demands of the existing plus the expanded fleet size. Muni also carried a project in the 1997 Capital Improvement Program for 26 expansion LRVs for ridership increases on the existing system, with no projected implementation date.

The 1999 SRTP assumed that the Third Street demand and the Mission Bay demand would be covered by an increase in fleet size totaling 25 vehicles. The first 15 vehicles would be added to the fleet for Third Street by 2004, and when coupled with a reduction in the spare ratio, would cover the Third Street peak demand of 18 vehicles. Ten additional vehicles would come in 2009 for Mission Bay ridership growth in the Third Street corridor.

Muni has now exercised the option on the Breda contract for the 15 additional vehicles, and this plan assumes that the first phase of Third Street can be operated with 151 vehicles in the fleet, with a peak demand of 117 vehicles. Muni is planning for the purchase of 10 additional vehicles in 2009 for Mission Bay ridership growth, and an additional 10 vehicles in 2015 for additional capacity on the existing system, principally on the L and N-lines. Muni would like to accelerate these purchases, if possible.

### b. Castro Shuttle

Muni has recognized that Metro riders on the inner portion of the subway from Castro Station to Embarcadero often have problems boarding trains. This problem is manifested mainly in the peak periods, and is worst in the AM peak period for the inbound (eastbound) direction. Frequently, inbound riders at Castro, Church and Van Ness cannot board trains, because the trains arrive at those stations fully loaded, with no room for the waiting passengers. In an attempt to mitigate this problem, in Spring 2001, Muni will begin operation of the Castro Shuttle, which will be operated by two three-car trainsets that shuttle between Castro and Embarcadero Stations, providing capacity enhancement on the more heavily used downtown portion of the subway. If this operation is successful in alleviating some overcrowding on the inner portion of the line without negatively affecting the operation of the full longer lines, Muni may seek to make this operation permanent. This could require the acquisition of six to ten additional cars in the future. The initial phase of this operation will occur during the time when the K-Ingleside line is undergoing a rerailing project, and will be partially bus operated, requiring fewer LRVs for operation, thus peak vehicle requirements are not expected to be affected until the K-line becomes fully operational again in 2003.

### 2. Historic Streetcars

Muni's F-line ridership has grown steadily since the line was introduced as a regular service in 1995, replacing the 8-Market trolley coach line. In 2000, an extension to Fisherman's Wharf was opened, which replaced the 32-Embarcadero motor coach line, and further increased ridership. Muni has planned for an expanded fleet size of historic vehicles, either through rehabilitation of existing unused historic cars on the property, acquisition of historic cars, or a combination of these strategies. This plan assumes that the active historic fleet will need to grow to accommodate ridership demand, in addition to any extensions or expansions of historic streetcar service.

The E-line Operating Plan, produced in June 2000, assumed that F-line peak demand would grow to 24 cars (31 total cars needed), and that a future E-line would require 6 cars in the peak (8 cars total needed), for a fleet of 39. This plan assumes that the active PCC and Milan cars available for regular service on the E and F-lines grows to 39 cars, with Special Service cars available for occasional substitution. If ridership grows faster than anticipated, however, additional cars may be needed.

## B. Muni Metro Expansion

In 1995, the San Francisco County Transportation Authority (SFCTA) published the 4-Corridors report, which established a phased multi-corridor approach to light rail expansion in San Francisco. The corridors listed below were identified in the report, and are currently the basis for moving forward with light rail expansion in San Francisco.

### 1. Third Street Light Rail Line and Central Subway

The largest expansion project currently underway is the Third Street Light Rail Project, which is a multi-phased extension to the Muni Metro system, and was identified in the 4-Corridors report as San Francisco's highest priority for rail expansion. Figure 6 is a map of the 3rd Street Project, Phases I and II.

#### a. Scope

Phase 1 of the Third Street project is the Initial Operating Segment (IOS), which will be a 5.4 mile extension of rail service from the corner of King and 4th Streets to a terminal near the Bayshore Caltrain Station. Phase 2 of the 3rd Street Light Rail Project will construct the new Central Subway, which will be a new subway constructed on an alignment from the vicinity of the Caltrain Terminal through the South-of-Market, Union Square, and Chinatown neighborhoods. The Central Subway and the connecting surface trackage will be approximately 1.7 miles long.

The Third Street IOS is likely to be operated as an extension of the J-Church line, and LRVs will operate over the existing J-line trackage into the Market Street Subway, through the MMT, then via the MMX trackage to King & 4th Streets, and then continue along the new surface extension on 3rd Street through the Bayview and Hunter's Point neighborhoods. When the Central Subway is completed in 2009, trains from the 3rd Street line will operate into the Central Subway, instead of via the MMX and into the Market Street Subway. Peak headways are planned to be every 6 minutes for the IOS, and every 5 minutes for the Central Subway.

Phase 1 of the 3rd Street Project includes the construction of the Metro East light rail maintenance facility, which will be Muni's second light rail operating division, and which will provide much-needed relief for the overcrowded Green Division and the Geneva facility. This project also includes the acquisition of 15 additional Breda LRV-3s.

The current Muni Metro system plus Phase 1 of 3rd Street is expected to require 117 peak vehicles to operate. The fleet is expected to grow to 151 vehicles to accommodate this need. The Third Street line traverses the Mission Bay area, which is experiencing extensive development. As ridership grows in this area, Muni may need to add additional vehicles to handle the increased ridership, and additional lines may be extended over portions of the 3rd Street line to a short-line terminal in the Central Waterfront area to serve the Mission Bay demand. Muni expects to add 8 peak vehicles in approximately 2008/09 for increased ridership in the Mission Bay area. When the Central Subway opens, Muni will also need to add an additional 3 peak vehicles. Ridership demand in the Third Street corridor is expected to be approximately 71,000 by 2015 for the 3rd Street line (IOS and Central Subway phases). Figure 7 shows the expected peak vehicle assignments for the Muni Metro system as a whole, and for the planned phases of the 3rd Street project through 2015.

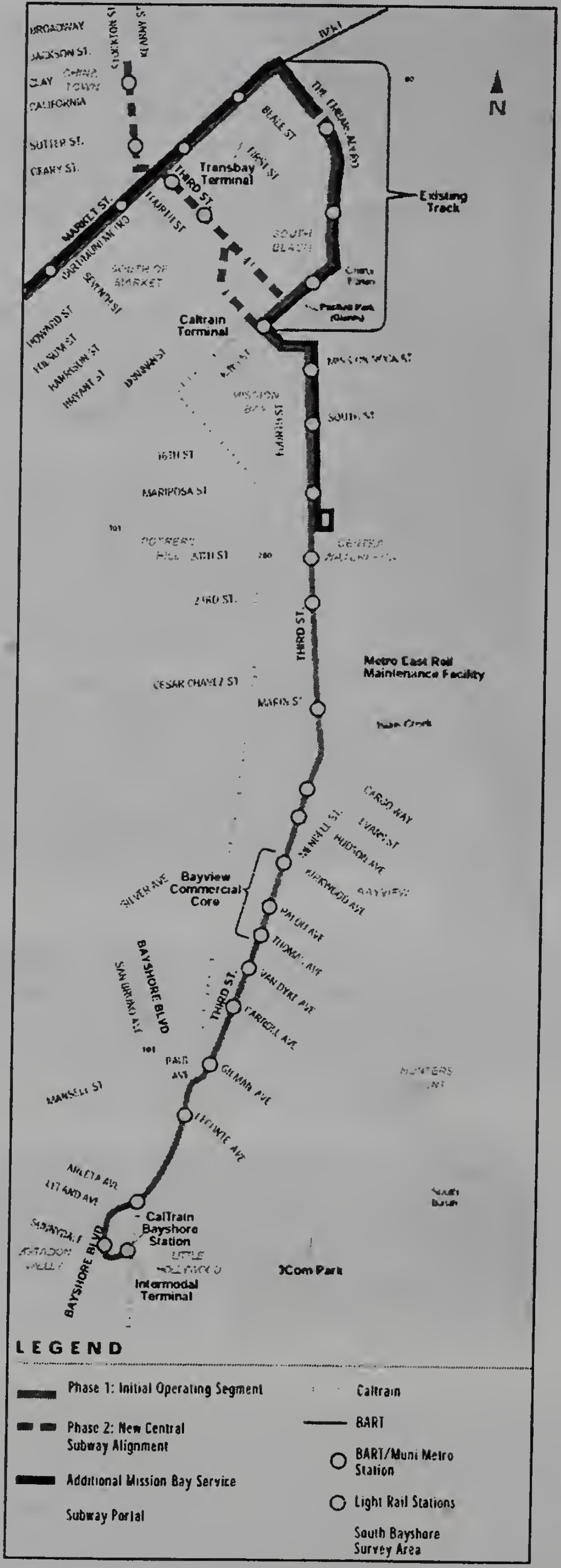
### b. Cost

Phase 1 of the project is currently expected to cost approximately $530 million. Phase 2 of the project is estimated to cost approximately $880 million. Phase 1 of the project is being funded largely with local Proposition B funds. Muni expects to fund Phase 2 with a mixture of local, state and federal funding.

### c. Status

Muni performed a planning-level study on the 3rd Street corridor in 1992 and 1993. The Third Street planning study led to an MIS, and then to an EIS/EIR, followed by an approved funding plan. The project is currently in final design, and construction is expected to begin on the IOS in the Fall of 2001.

**Figure 6 Third Street Light Rail Project**



## Figure 7 - Projected Operating Statistics

| YEAR | LINE | PEAK LRVs | TOTAL LRV FLEET | OVERALL SPARE RATIO |
|---|---|---|---|---|
| **2000** | J | 11 | | |
| | K | 11 | | |
| | L | 26 | | |
| | M | 22 | | |
| | N to Caltrain | 34 | | |
| | TOTAL | 104 | 136 | 31% |
| | | | | |
| **2001** | J | 11 | | |
| | K - Shuttle during rerailing | 5 | | |
| | L | 26 | | |
| | M | 22 | | |
| | N to Caltrain | 34 | | |
| | Castro Shuttle | 6 | | |
| | TOTAL | 104 | 136 | 31% |
| | | | | |
| **2004** | J to 3rd Street (IOS) | 24 | | |
| | K | 11 | | |
| | L | 26 | | |
| | M | 22 | | |
| | N to Caltrain | 34 | | |
| | Castro Shuttle | 6 | | |
| | TOTAL | 123 | 151 | 23% |
| | | | | |
| **2009** | J | 11 | | |
| | K | 11 | | |
| | L | 26 | | |
| | M | 22 | | |
| | N to Caltrain | 34 | | |
| | NCS shortline to Mariposa | 8 | | |
| | 3rd Street NCS Trunk | 16 | | |
| | Castro Shuttle | 6 | | |
| | TOTAL | 134 | 161 | 20% |
| | | | | |
| **2015** | J | 11 | | |
| | K | 11 | | |
| | L | 30 | | |
| | M | 22 | | |
| | N to Caltrain | 38 | | |
| | NCS shortline to Mariposa | 8 | | |
| | 3rd Street NCS Trunk | 16 | | |
| | Castro Shuttle | 6 | | |
| | TOTAL | 142 | 171 | 20% |

*Source: Based on Table 1-1, Final Conceptual Engineering Report for Metro East (10/99).
Information updated based on actual peak vehicle demand in 2000/2001.*

*Notes: Vehicles planned for additional capacity in 2015 assigned to L and N-lines.
Assumes Mariposa (Mission Bay) service in 2015 provided by N-Line,
but could instead be provided by an NCS shortline train.*

### d. Schedule

The current schedule for the 3rd Street Light Rail project is as follows:

**Figure 8 3rd Street Light Rail Project Schedule**

| Element | Schedule |
|---|---|
| Select Locally-Preferred Alternative | Completed June 23, 1998 |
| Environmental Review | EIR Certified December 3, 1998<br>EIS Record of Decision (ROD) March 16, 1999 |
| Policy Board Approval for 2-Phase Project | Completed January 19, 1999 |
| **Phase 1 (IOS)** | |
| Conceptual Engineering | Completed Summer 1999 |
| Preliminary Engineering | Completed January 31, 2000 |
| FTA Approval of Preliminary Engineering and Approval to Begin Final Design | Received April 7, 2000 |
| Final Design | 2001 |
| Construction | 2001 through 2004 |
| Begin Revenue Service | November 2004 |
| **Phase 2 (Central Subway)** | |
| Preliminary Engineering | 2000 |
| Final Design | 2003-2006 |
| Construction | 2006-2009 |
| Begin Revenue Service | 2009 |

## 2. Geary

Geary is one of the highest volume transit corridors in the city (approximately 45,000 riders per day), and is currently handled entirely with diesel buses. Following the completion of the 3rd Street study, Muni performed a planning-level study for the Geary corridor in 1994 and 1995. The Geary study recommended moving forward to a Major Investment Study (MIS) and EIS/EIR with three alternatives:

- Light Rail, all-surface
- Light rail, surface and subway combination
- Trolley Coach, surface and subway combination

Muni's governing board accepted the report, and elected not to move forward to an MIS and EIS/EIR until a viable financial plan could be developed. The board also elected not to select a preferred mode and alignment. Muni does not yet have a viable financial plan for this project, though it is the next highest priority for expansion after the first two segments of the 3rd Street line open. The Central Subway phase of Third Street is being constructed so that it could connect with any future Geary subway.

### 3. Chinatown/North Beach

The third priority for rail expansion is to extend the Central Subway northward into Chinatown and North Beach, possibly coming to street-level for a partial surface alignment. No significant work has been performed on this potential expansion, but it is next in priority after Geary.

### 4. Van Ness

The fourth priority for rail expansion is for rail transit in the Van Ness corridor. No significant work has been performed on this potential expansion.

### 5. 3rd Street Extensions

Several southerly extensions of the 3rd Street line have been proposed, but are not actively being planned. The extensions that have been suggested are to Candlestick Point, to the Hunters Point Naval Shipyard, or to the Balboa Park BART Station via Geneva Avenue. These extensions were originally considered as part of the 3rd Street planning studies, but have not been included in the IOS or Phase 2. An inter-county transportation study is currently being performed in cooperation with San Mateo County to investigate options in this vicinity.

## C. Historic LRV Expansion

In April 2000, Muni opened an extension of the F-Market HSC line to Fisherman's Wharf. This extension added approximately 5 miles of new revenue trackage to the HSC system. Several additional HSC extensions have been discussed in San Francisco.

### 1. E-Embarcadero

The E-Embarcadero has been proposed as a new HSC line along the Embarcadero, which would share trackage with the F-Market, and with the N-line operation on the MMX. As part of the construction of trackage for the F-Market line, Muni constructed the E-line Connector Track, which connects the F-line trackage on the northern Embarcadero with the MMX trackage on the southern Embarcadero. A preliminary operating plan was prepared for the E-line in July 2000, which identified significant vehicle procurement needs, maintenance facility constraints, operational constraints and capital and operating funding needs. It is unlikely that these constraints could be removed prior to 2004. Based on these constraints, the estimated time needed to implement the E-line is 3 to 4 years from the time the decision is made to proceed with the project. The E-line is currently a planning project, and is undergoing further analysis.

### 2. G-Golden Gate Park

The G-Golden Gate Park line has been proposed primarily as a tourist operation, and would share trackage with the F-Market line and the N-Judah line, but would also require some new construction in Golden Gate Park. A Muni G-Line Feasibility Study was prepared by the SFCTA in July 2000. The G-line has constraints similar to the issues noted above for the E-line, and again, it is unlikely that these constraints could be removed prior to 2004. The G-line is not currently an active planning project at Muni.

### 3. F-Market Extension to The Presidio

An extension of the F-Market line from Fisherman's Wharf, through the Fort Mason Tunnel and the Marina District to The Presidio has been proposed, again primarily as a tourist operation. This is not currently an active planning project at Muni.

## D. Metro East Maintenance Facility

As part of the 3rd Street Light Rail Project, Muni will build the new Muni Metro East Light Rail Maintenance and Operations Facility (Metro East) for light rail vehicles in the Central Waterfront area. Figure 9 shows the how vehicle assignments for Muni's maintenance facilities are expected to change when Metro East opens.

### 1. Scope

Metro East will be built on a 17-acre vacant former Western Pacific Railroad site just northwest of Pier 80, at the corner of 25th Street and Illinois Street. This facility is needed to support the new Third Street Light Rail Line as well as to relieve the over-crowded conditions at the Metro Green/Geneva Light Rail Facility.

Metro East will be a stand-alone facility capable of supporting an 80-LRV fleet, initially built within 13-acres of the 17-acre site. Functions provided onsite will be car cleaning, fare extraction, sanding, preventive maintenance (3 positions), running repair (9 positions), heavy repair/wheel truing (2 tracks), paint and body, and material/parts storage. Additional support shops onsite will be a Truck Shop, Pantograph Shop, HVAC Shop, Metal Shop, Pneumatic Shop, Welding Shop, Machine Shop, and others. The shop buildings will be built out to the size needed to support a 100-LRV fleet, even though this size fleet will not be supported initially. This is being done because of the difficulty of expanding the facility once it is in operation.

The yard can be readily expanded to accommodate 100 LRVs, which is expected to be needed by 2015. While the Metro East facility will be operating for the most part independently of Metro Green/Geneva (Muni's only other LRV facility), there will be functions that will not be duplicated at Metro East, which are better served being centralized at Metro Green (cost effectiveness, etc.). These functions include major overhauls, unit repairs, systemwide glass, and upholstery.

The Metro East Facility will consist of the following:

- Steel framed Maintenance Shop Building with a partial second floor for the Transportation Division and other support services and with a partial mezzanine level (total building is 180,000 sq.ft.) This building will be on piles. (Total building height limit is 40 feet)
- Paint and Body Shop/MOW building (25,000 sf), also steel framed, and pile supported.
- Meet and Greet structure on mat or pile foundations.
- Paved, open yard with tracks and overhead wires for LRV storage. The yard will also have a dedicated ATCS test track.
- Onsite employee and non-revenue vehicle parking lot for approximately 180 vehicles
- Traction power substations.
- The project also includes building new access roads, utilities and tracks from Third

Street to the facility via 25th (primary entrance/exit) and Cesar Chavez Streets (secondary entrance/exit).

The facility will operate on two to three shifts with an initial staff of about 200 to 250 (some of which will be transferred from Green) for the initial fleet of 80 LRVs.

## 2. Cost

Based on the Conceptual Engineering Report (CER), the total construction cost for the initial facility to support 80 LRVs is estimated at $92.5 million, in 1999 dollars. This cost includes (1) a separate advanced soils contract to stabilize or densify the soil (as mitigation for soil liquefaction), and (2) a main yard/building contract which includes a state-of-the-art yard signaling system capable of controlling the electric track switches remotely, procurement of new shop equipment and traction power substations.

## 3. Status

The Metro East Project completed the EIR/EIS process under the Third Street Light Rail Project and received approvals from the FTA and City Planning Department. The conceptual design for the project started in July 1998 under a consultant contract. Currently, the project is in the detailed design phase that started in December of 1999 and will conclude in the spring/summer of 2001.

## 4. Schedule

Advanced soil compaction work began in October 2000 to allow the completion of this contract by Fall of 2001 so that the main construction contract can proceed. The final design for the yard/shops will continue while the soils work is proceeding, and will be completed when the soils contract is completed. The actual start of construction of buildings/yard is scheduled to start in November or December 2001, after a 5-month bid and award period. The facility will be tested, commissioned and ready for operation by approximately the first quarter of 2004.

## 5. Future Expansion of Metro East

Metro East has been designed so that it can be expanded from an 80-car facility in its initial configuration to a 100-car facility. Muni expects to need to expand Metro East to its 100-car configuration by 2015 at the latest. This plan anticipates that Muni will need to assign 90 vehicles to Metro East by 2015 to handle 3rd Street, the New Central Subway, Mission Bay ridership growth and capacity enhancement on the existing system.

## Figure 9 - Fleet Storage Assignments

### Green/Geneva

| | FY2001 thru 2004 | FY2004-2008 | 2009 | 2015 |
|---|---|---|---|---|
| **Peak Vehicles** | | | | |
| F/E | 24 | 34 | 34 | 38 |
| J | 11 | 0 | 0 | 0 |
| K | 11 | 81 | 11 | 11 |
| J | 26 | 26 | 26 | 30 |
| M | 22 | 22 | 22 | 22 |
| N | 38 | 0 | 0 | 0 |
| Castro Shuttle | 6 | 8 | 8 | 8 |
| **Total Peak Vehicles** | 134 | 38 | 38 | 103 |
| | | | | |
| **Fleet Assigned** | | | | |
| Design Capacity | 130 | 130 | 130 | 130 |
| LRV Fleet | 136 | 81 | 81 | 81 |
| PCC/Milan Fleet (see note) | 22 | 38 | 38 | 38 |
| HSC Special Service (see note) | 26 | 20 | 20 | 20 |
| **TOTAL** | 183 | 140 | 140 | 140 |
| | | | | |
| **Facility Spare Ratio** | | | | |
| **LRV Spare Ratio** | 24% | 25% | 25% | 17% |
| **PCC/HSC Spare Ratio** | 13% | 15% | 15% | 15% |

### Metro East

| | FY2001 thru 2004 | FY2004-2008 | 2009 | 2015 |
|---|---|---|---|---|
| **Peak Vehicles** | | | | |
| J | 0 | 24 | 11 | 11 |
| N | 0 | 34 | 38 | 38 |
| 3rd St NCS Mariposa | 0 | 0 | 8 | 8 |
| 3rd St NCS Trunk | 0 | 0 | 16 | 16 |
| **Total Peak Vehicles** | 0 | 58 | 56 | 73 |
| | | | | |
| **Fleet Assigned** | | | | |
| **Design Capacity** | 0 | 50 | 80 | 100 |
| LRV Fleet | 0 | 70 | 90 | 90 |
| | | | | |
| **Facility Spare Ratio** | | | | |
| **LRV Spare Ratio** | - | 21% | 15% | 23% |

Note: PCC/Milan fleet vehicles are cars normally assigned to regular F-line service.
Note: Special Service cars are not included in calculations for spare ratio, but are included here for purposes of determining needed storage requirements.
Note: Ex-Muni PCC cars stored at Piers 72 and 80 not counted as Special Service cars for this purpose.

## 5. Demand for Revenue Vehicles

Muni's demand for revenue vehicles is based on running times, ridership levels, analysis of the desired load factors, and on the operating demands and constraints of the system.

### A. Running Times

Average round-trip running times for the six light rail lines are shown in Figure 10. This figure also shows the scheduled peak vehicle demand, given average cycle times, and the headways necessary to serve the anticipated ridership with acceptable load standards. Dividing the cycle time by the number of vehicles per hour yields the peak vehicle demand.

### B. Ridership

Muni's LRV ridership has fluctuated over the last 10 years, as shown in Figure 11. Generally, ridership dropped between FY89/90 and FY95/96, and then began growing through FY97/98, with a strong increase in FY97/98. Service delivery problems related to the multiple operational changes initiated simultaneously in August 1998 caused a drop in ridership for FY98/99, but ridership grew substantially again in FY 99/00, as service has improved significantly as the ATCS system has matured.

Average weekday ridership trends on a line-by-line basis have also followed similar patterns. Figure 12 shows average weekday ridership for the F-line and the five Metro lines over the last four years.

### C. Load Factors

Load factor is a measure of crowding onboard a transit vehicle. Muni's load factors are among the highest in the transit industry. For LRVs, in FY 2001, Muni schedules vehicles to accommodate an average maximum peak load per car of 119 riders per car over the peak period, in a vehicle with an average of 58 seats. This load is represented as 1.0. This load factor does not represent the crush-loaded maximum capacity of the car, but is instead the target average load for scheduling purposes that Muni has traditionally used. Obviously, as an average, some cars in the peak period will be loaded heavier than this, and some will not be loaded as heavy. To illustrate: if every car in the two-hour peak were to have a load factor of 1.0, then every car would have 119 passengers onboard at the Maximum Load Point (MLP). If every car were to have a full-seated load (58 passengers), the load factor would be 0.48. Proposition E, passed by San Francisco voters in November 1999, mandated service and performance standards for Muni that includes a peak hour load factor average of 0.85.

Figure 13 shows the load factors that the F-line and the Metro lines experience in the heaviest hour of the peak. For the F-line, in FY99/00, AM load factors averaged 0.52, and PM load factors averaged higher, up to 0.59. For the Metro lines, AM load factors averaged between 0.75 and 0.95 of the maximum load, and for the PM peak, load factors averaged between 0.79 and 0.90.

Using Muni's traditional standard, this analysis indicates that the scheduled number of vehicles on several of the five Metro lines is appropriate for the loads currently being experienced, though the K, L, and N-lines are experiencing average loads at the upper end of the range tolerated. As the loads approach the maximum load factor for planning purposes, the operation of additional vehicles is appropriate to relieve overcrowding. Using the Proposition E

## Figure 10 - Weekday Running Times

June 2000

| | AM Peak 7-9am | | | | | | Midday | | | | | | PM Peak 4-7pm | | | | | | Evening 9pm | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line | Avg RT Running Time | Avg Layover Time | Avg Cycle Time | Head way (Min) | Trains | Cars | Avg RT Running Time | Avg Layover Time | Avg Cycle Time | Head way (Min) | Trains | Cars | Avg RT Running Time | Avg Layover Time | Avg Cycle Time | Head way (Min) | Trains | Cars | Avg RT Running Time | Avg Layover Time | Avg Cycle Time | Head way (Min) | Trains | Cars |
| **PCC/Historic Streetcar** | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 77 | 25 | 102 | 6 | 17 | 17 | 97 | 23 | 120 | 8 | 15 | 15 | 98 | 20 | 118 | 7 | 17 | 17 | 82 | 21 | 103 | 15 | 7 | 7 |
| **LRV - Muni Metro** | | | | | | | | | | | | | | | | | | | | | | | | |
| J | 67 | 19 | 86 | 8 | 11 | 11 | 70 | 20 | 90 | 10 | 9 | 9 | 68 | 20 | 88 | 8 | 11 | 11 | 66 | 21 | 87 | 20 | 5 | 5 |
| K | 75 | 12 | 87 | 8 | 11 | 11 | 73 | 25 | 98 | 10 | 10 | 10 | 79 | 21 | 100 | 9 | 11 | 11 | 64 | 21 | 85 | 15 | 6 | 6 |
| L | 70 | 14 | 84 | 7 | 12 | 24 | 69 | 22 | 91 | 10 | 10 | 10 | 75 | 16 | 91 | 7 | 13 | 26 | 66 | 17 | 83 | 15 | 6 | 6 |
| M | 73 | 14 | 87 | 8 | 11 | 22 | 79 | 21 | 100 | 10 | 10 | 20 | 80 | 18 | 98 | 9 | 11 | 22 | 64 | 19 | 83 | 20 | 5 | 5 |
| N | 98 | 20 | 118 | 7 | 17 | 34 | 100 | 30 | 130 | 10 | 13 | 26 | 100 | 18 | 118 | 7 | 17 | 34 | 88 | 24 | 112 | 12 | 10 | 20 |
| **LRV - Muni Metro Subtotal** | | | | | 62 | 102 | | | | | 52 | 75 | | | | | 63 | 104 | | | | | 32 | 42 |
| **TOTAL** | | | | | 79 | 119 | | | | | 67 | 90 | | | | | 80 | 121 | | | | | 39 | 49 |

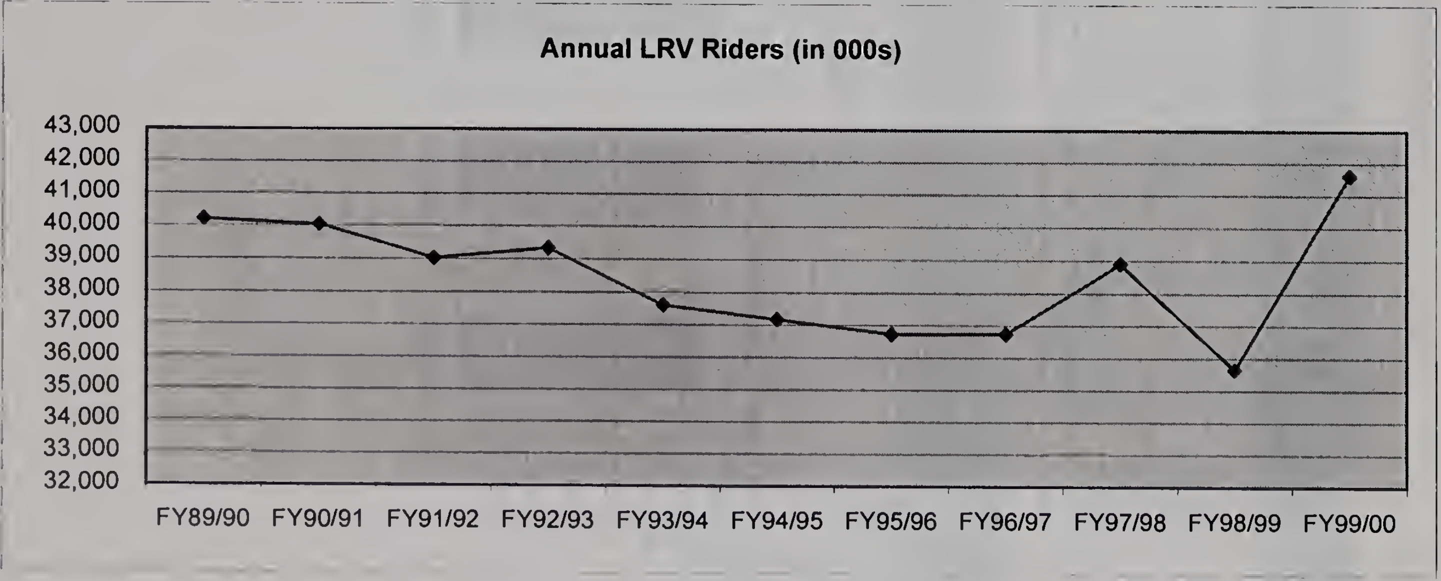
Notes: 1) F-line equipment demand increased by 4 HSCs as assigned when traffic conditions warrant.

*Source: Muni Schedules Dept. Rotations for June 2000*

## Figure 11 - Annual LRV Ridership

| | FY89/90 | FY90/91 | FY91/92 | FY92/93 | FY93/94 | FY94/95 | FY95/96 | FY96/97 | FY97/98 | FY98/99 | FY99/00 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Annual LRV Riders (in 000s)** | 40,214 | 40,044 | 39,034 | 39,332 | 37,615 | 37,178 | 36,728 | 36,738 | 38,898 | 35,660 | 41,610 |
| **Percent Change from Prev. Year** | | 0% | -3% | 1% | -4% | -1% | -1% | 0% | 6% | -8% | 17% |

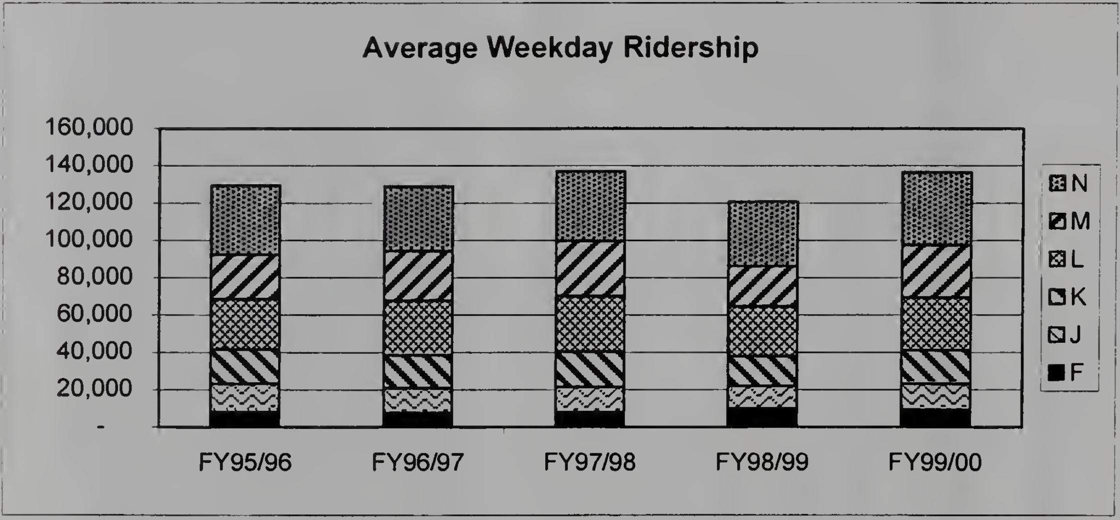
*Source: National Transit Database*



## Figure 12 - Average Weekday Ridership

| Type | Line | FY95/96 | FY96/97 | FY97/98 | FY98/99 | FY99/00 |
|---|---|---|---|---|---|---|
| HSC | F | 8,099 | 7,596 | 7,896 | 9,805 | 9,353 |
| METRO | J | 15,067 | 13,301 | 13,486 | 12,025 | 13,680 |
|  | K | 18,395 | 17,575 | 18,893 | 16,050 | 18,087 |
|  | L | 26,850 | 29,214 | 29,665 | 26,781 | 28,209 |
|  | M | 23,821 | 26,668 | 29,739 | 21,442 | 28,088 |
|  | N | 37,383 | 34,713 | 37,366 | 34,607 | 39,051 |
|  | **Metro Subtotal** | 121,516 | 121,471 | 129,149 | 110,905 | 127,115 |
|  | **LRV Total** | **129,615** | **129,067** | **137,045** | **120,710** | **136,468** |

*Source: Schedules Dept. Annual Monitoring*



## Figure 13 - Load Factors

**AM PEAK HOUR (8-9am)**

| Line | Avg. No. Seats per Car | Max Avg Load for Planning Purposes | Target Load Factor | Prop E Target Load Factor | Actual Avg AM Peak Load | Avg AM Standees per Car | Actual Avg AM Load Factor | Actual AM Load as % of Seats | At or Above Target | At or Above Prop E Target | Percent of Target | Percent of Prop E Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 38 | 70 | 1.0 | 0.85 | 36.3 | 0 | 0.52 | 96% | | | 52% | 61% |
| J | 58 | 119 | 1.0 | 0.85 | 90.0 | 32 | 0.76 | 155% | | | 76% | 89% |
| K | 58 | 119 | 1.0 | 0.85 | 105.1 | 47.1 | 0.88 | 181% | | Y | 88% | 104% |
| L | 58 | 119 | 1.0 | 0.85 | 104.8 | 46.8 | 0.88 | 181% | | Y | 88% | 104% |
| M | 58 | 119 | 1.0 | 0.85 | 89.2 | 31.2 | 0.75 | 154% | | | 75% | 88% |
| N | 58 | 119 | 1.0 | 0.85 | 113.1 | 55.1 | 0.95 | 195% | | Y | 95% | 112% |

**PM PEAK HOUR (5-6pm)**

| Line | Avg. No. Seats per Car | Max Avg Load for Planning Purposes | Target Load Factor | Prop E Target Load Factor | Actual Avg PM Peak Load | Avg PM Standees per Car | Actual Avg PM Load Factor | Actual PM Load as % of Seats | At or Above Target | At or Above Prop E Target | Percent of Target | Percent of Prop E Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 38 | 70 | 1.0 | 0.85 | 41.1 | 3.1 | 0.59 | 108% | | | 59% | 69% |
| J | 58 | 119 | 1.0 | 0.85 | 94.3 | 36.3 | 0.79 | 163% | | | 79% | 93% |
| K | 58 | 119 | 1.0 | 0.85 | 102.5 | 44.5 | 0.86 | 177% | | Y | 86% | 101% |
| L | 58 | 119 | 1.0 | 0.85 | 103.1 | 45.1 | 0.87 | 178% | | Y | 87% | 102% |
| M | 58 | 119 | 1.0 | 0.85 | 99.3 | 41.3 | 0.83 | 171% | | | 83% | 98% |
| N | 58 | 119 | 1.0 | 0.85 | 106.9 | 48.9 | 0.90 | 184% | | Y | 90% | 106% |

*Source: Muni Schedules Dept. FY99-00 Monitoring* performance standards, however, three lines (K, L and N-lines) are all above the load factor standard established for both the AM and PM peaks. In FY2002, Muni will be reconciling these standards for load factor analysis, and doing additional analysis on the crowding onboard the vehicles. Additional data collection is also warranted to verify the loads reported.

Loads on the F-line appear somewhat lighter, although several factors should be noted. First, in March 2000, the F-line extension to Fisherman's Wharf was opened. Initially, not enough running time was assigned to this new segment, and the traffic conditions in which the cars operate have proven more difficult than anticipated. Muni is currently testing several different car assignment strategies and running time allocations for this line. Second, the F-line data included here is based on only two days worth of checks in the winter, which could lead to data that is not entirely representative of the performance of the line. Given that this line is anticipated to experience very heavy ridership during the summer, due to the large number of tourist destinations along the line, further data collection is warranted.

## D. Peak Vehicle Demand

### 1. Current Demand

The demand for peak vehicles has changed over the last few years, due to a number of factors. Figure 14 shows the history of peak vehicle demand over the last five years. Figures 15-17 show current (June 2000) vehicle demand by hour of the day for weekday, Saturday and Sunday service schedules.

**Figure 14 Peak Vehicle Demand**

| | Previous Maximum | 8/96 | 8/97 | 8/98 | 8/99 | Current (8/00) |
|---|---|---|---|---|---|---|
| Metro | 109 | 90 | 90 | 90 | 102 | 104 |
| HSC | N/A | 9 | 9 | 9 | 14 | 21 |

Peak vehicle demand has not always correlated exactly with passenger demand, due to some limitations on throughput that have constrained service delivery. Prior to August 1998, Metro throughput was constrained by the capacity of the turnback operation at Embarcadero Station. The configuration at Embarcadero Station prior to August 1998 was that all trains turned back at the station platforms, using a double-crossover interlocking just west of the station platforms. This configuration meant that trains leaving the station delayed trains entering the station.

In August 1998, a number of simultaneous changes occurred on Muni Metro. Muni began using Alcatel's Seltrac Advanced Train Control System (ATCS) to control trains in the subway. Muni also began using the new Muni Metro Turnback (MMT), just east of Embarcadero Station, which was an underground turnback facility with several pocket tracks for turning back trains independently of each other, and without blocking through movements. The use of the MMT meant that trains could turn back outside of the station platforms, without interfering with trains entering the station. At this same time, the N-Judah line was extended into the South of Market area on the Muni Metro Extension (MMX), and Proof-of-Payment (POP) fare collection was instituted on the N-line. The POP conversion also meant that the N-line trains were converted to one-person operation of two car trains at this same time, which was a new operating scenario for Muni.

## Figure 15 - Hourly Equipment Demand (Weekday)

June 2000

| Line | 12a | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12n | 1p | 2p | 3p | 4p | 5p | 6p | 7p | 8p | 9p | 10p | 11p | 12x | 1x | 2x | 3x |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PCC/Historic Streetcar** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 0 | 0 | 0 | 0 | 2 | 7 | 13 | 16 | 17 | 17 | 16 | 15 | 15 | 15 | 16 | 16 | 17 | 17 | 17 | 14 | 10 | 8 | 7 | 7 | 7 | 6 | 2 | 0 |
| **LRV - Muni Metro** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| J | 0 | 0 | 0 | 0 | 3 | 5 | 7 | 10 | 11 | 11 | 9 | 9 | 9 | 9 | 9 | 10 | 11 | 11 | 10 | 8 | 7 | 6 | 5 | 4 | 3 | 0 | 0 | 0 |
| K | 0 | 0 | 0 | 0 | 4 | 5 | 8 | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 10 | 9 | 7 | 5 | 5 | 4 | 2 | 0 | 0 | 0 |
| L | 0 | 0 | 0 | 0 | 5 | 12 | 22 | 24 | 24 | 24 | 14 | 10 | 9 | 12 | 22 | 26 | 26 | 26 | 26 | 18 | 9 | 9 | 5 | 4 | 3 | 0 | 0 | 0 |
| M | 0 | 0 | 0 | 0 | 1 | 4 | 13 | 22 | 22 | 22 | 20 | 20 | 20 | 20 | 20 | 22 | 22 | 22 | 19 | 11 | 8 | 6 | 4 | 4 | 2 | 0 | 0 | 0 |
| N | 0 | 0 | 0 | 0 | 12 | 22 | 34 | 34 | 34 | 34 | 30 | 26 | 26 | 26 | 28 | 34 | 34 | 34 | 34 | 34 | 28 | 24 | 20 | 18 | 18 | 2 | 0 | 0 |
| LRV - Muni Metro Subtotal | 0 | 0 | 0 | 0 | 25 | 48 | 84 | 101 | 102 | 102 | 83 | 75 | 74 | 77 | 90 | 103 | 104 | 104 | 99 | 80 | 59 | 50 | 39 | 34 | 28 | 2 | 0 | 0 |
| TOTAL | 0 | 0 | 0 | 0 | 27 | 55 | 97 | 117 | 119 | 119 | 99 | 90 | 89 | 92 | 106 | 119 | 121 | 121 | 116 | 94 | 69 | 58 | 46 | 41 | 35 | 8 | 2 | 0 |

Notes: 1) F-line equipment demand increased by 4 HSCs as assigned when traffic conditions warrant.

*Source: Muni Schedules Dept.*

## Figure 16 - Hourly Equipment Demand (Saturday)

June 2000

| Line | 12m | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12n | 1p | 2p | 3p | 4p | 5p | 6p | 7p | 8p | 9p | 10p | 11p | 12x | 1x | 2x | 3x |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PCC/Historic Streecar** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **F** | 0 | 0 | 0 | 0 | 0 | 3 | 7 | 10 | 12 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 9 | 7 | 7 | 7 | 7 | 7 | 5 | 1 | 0 |
| **LRV - Muni Metro** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **J** | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| **K** | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 5 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 5 | 4 | 4 | 4 | 2 | 0 | 0 | 0 |
| **L** | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 5 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 6 | 5 | 4 | 4 | 3 | 0 | 0 | 0 |
| **M** | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 6 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 7 | 5 | 5 | 5 | 5 | 2 | 0 | 0 | 0 |
| **N** | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 22 | 15 | 11 | 9 | 9 | 9 | 2 | 0 | 0 |
| **LRV - Muni Metro Subtotal** | 0 | 0 | 0 | 0 | 3 | 8 | 17 | 45 | 53 | 55 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 53 | 35 | 29 | 29 | 29 | 29 | 2 | 0 | 0 |
| **TOTAL** | 0 | 0 | 0 | 0 | 3 | 11 | 24 | 55 | 65 | 68 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 69 | 59 | 42 | 36 | 33 | 33 | 27 | 7 | 1 | 0 |

Notes: 1) F-line equipment demand increased by 4 HSCs as assigned when traffic conditions warrant.

*Source: Muni Schedules Dept.*

## Figure 17 - Hourly Equipment Demand (Sunday)

June 2000

| Line | 12a | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12n | 1p | 2p | 3p | 4p | 5p | 6p | 7p | 8p | 9p | 10p | 11p | 12x | 1x | 2x | 3x |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PCC/Historic Streetcar** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **F** | 0 | 0 | 0 | 0 | 0 | 3 | 7 | 10 | 12 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 9 | 7 | 7 | 7 | 7 | 7 | 5 | 1 | 0 |
| **LRV - Muni Metro** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **J** | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 3 | 3 | 3 | 3 | 0 | 0 | 0 |
| **K** | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 2 | 4 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 3 | 2 | 2 | 2 | 0 | 0 | 0 |
| **L** | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 4 | 5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 3 | 3 | 2 | 2 | 2 | 0 | 0 |
| **M** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 5 | 3 | 3 | 3 | 3 | 0 | 0 | 0 |
| **N** | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 17 | 17 | 19 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 19 | 11 | 5 | 4 | 4 | 4 | 1 | 0 | 0 |
| **LRV - Muni Metro Subtotal** | 0 | 0 | 0 | 0 | 3 | 6 | 10 | 30 | 36 | 42 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 43 | 31 | 17 | 15 | 14 | 14 | 3 | 0 | 0 |
| **TOTAL** | 0 | 0 | 0 | 0 | 3 | 9 | 17 | 40 | 48 | 55 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 52 | 38 | 24 | 22 | 21 | 21 | 8 | 1 | 0 |

Notes: 1) F-line equipment demand increased by 4 HSCs as assigned when traffic conditions warrant.

*Source Muni Schedules Dept.*

## Figure 18 - Planned Service Changes

Adjustments to Peak Vehicle Demand

| | Actual | Projected | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FY | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 | 07/08 | 08/09 | 09/10 | 10/11 | 11/12 | 12/13 | 13/14 | 14/15 | 15/16 | 16/17 | 17/18 | 18/19 | 19/20 |
| **LRV** | | | | | | | | | | | | | | | | | | | | | |
| March 2000 Sign-Up | -2 | | | | | | | | | | | | | | | | | | | | |
| Castro Shuttle* | | | | 6 | | | | | | | | | | | | | | | | | |
| Third St LRT Startup | | | | | 13 | | | | | | | | | | | | | | | | |
| Add'l Mission Bay Service | | | | | | | | | | 8 | | | | | | | | | | | |
| Central Subway | | | | | | | | | | 3 | | | | | | | | | | | |
| Additional Capacity | | | | | | | | | | | | | | | | 8 | | | | | |
| **Total** | -2 | 0 | 0 | 6 | 13 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 |
| **HSC** | | | | | | | | | | | | | | | | | | | | | |
| F-line Wharf Extension Startup | 3 | | | | | | | | | | | | | | | | | | | | |
| F-line Service Increase | 4 | 3 | | 4 | | | | | | | | | | | | | | | | | |
| E-line Startup | | | | | 6 | | | | | | | | | | | | | | | | |
| **Total** | 7 | 3 | 0 | 4 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: Castro Shuttle is expected to begin operation in Spring 2001. Due to partial K-line shutdown for rerailing, peak demand would not be affected until 2002/03, when the K-line returns to full operation.

*Source: 1) LRV projected vehicle requirement changes based on Metro East CER (10/99).*
*2) HSC projected vehicle requirement changes based on Preliminary E-Embarcadero Operating Plan (6/00).*

## Figure 19 - Peak Vehicle Demand

| | Actual | Projected | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FY** | **99/00** | **00/01** | **01/02** | **02/03** | **03/04** | **04/05** | **05/06** | **06/07** | **07/08** | **08/09** | **09/10** | **10/11** | **11/12** | **12/13** | **13/14** | **14/15** | **15/16** | **16/17** | **17/18** | **18/19** | **19/20** |
| **LRV** | | | | | | | | | | | | | | | | | | | | | |
| LRV Peak Vehicles (from 99-00 SRTP) | 106 | | | | | | | | | | | | | | | | | | | | |
| Modification (from Figure 17) | (2) | - | - | 6 | 13 | - | - | - | - | 11 | - | - | - | - | - | 8 | - | - | - | - | - |
| **Total LRV Peak Demand** | 104 | 104 | 104 | 110 | 123 | 123 | 123 | 123 | 123 | 134 | 134 | 134 | 134 | 134 | 134 | 142 | 142 | 142 | 142 | 142 | 142 |
| **HSC** | | | | | | | | | | | | | | | | | | | | | |
| HSC Peak Vehicles (99-00 SRTP) | 14 | | | | | | | | | | | | | | | | | | | | |
| Modification (from Figure 17) | 7 | 3 | - | 4 | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total HSC Peak Demand** | 21 | 24 | 24 | 28 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

Note: Castro Shuttle is expected to begin operation in Spring 2001. Due to partial K-line shutdown for rerailing, peak demand would not be affected until 2002/03, when the K-line returns to full operation.

*Source:* *1) LRV projected vehicle requirement changes based on Metro East CER (10/99).*
*2) HSC projected vehicle requirement changes based on Preliminary E-Embarcadero Operating Plan (6/00).*

Muni was unprepared for the impacts generated by the magnitude of the changes that occurred simultaneously in August 1998. Beginning with the implementation date and for several months thereafter, Muni experienced some severe teething problems bringing all of these changes into operation, which severely limited throughput in the subway and throughout the Metro system for a few months. These problems caused a drastic drop in Muni Metro ridership for FY1998-99.

Muni staff worked intensely over the next few months to solve the problems of changing the operation as thoroughly as was done in such a short time, and within a few months, the Metro was experiencing higher throughput than before the changes. Further refinements of the ATCS system and other changes have resulted in a much smoother operation. As a result, in FY99/00, ridership rose higher than the levels experienced from FY96/97 to FY97/98.

### 2. Future Demand

Muni anticipates a growing demand for LRV and HSC vehicles over the next 20 years, as shown in Figures 18 and 19. The additional LRV demand is based on a number of factors, including the additional cars required for the Castro Shuttle when the full K-line returns to operation in 2003, the planned startup of the Third Street Light Rail Line in 2004, the inauguration of Central Subway service in 2009, additional Mission Bay service in FY08/09, and additional cars for capacity enhancement in 2015..

Based on recent trends, Muni's LRV ridership is expected to grow by about 1.5% annually from FY2001 through FY2015. This translates to annual ridership on the LRV mode growing from approximately 41.6 million in FY2000 to 51.2 million in FY2015, an increase of almost 10 million riders or close to 20%. To keep up with the increased demand, Muni proposes to add 10 LRVs in 2015 to expand capacity on the existing LRV lines. The addition of these vehicles would maintain the projected AM and PM peak load factors at about the same levels as were experienced in FY2000, as shown in Figure 20.

In addition, as Muni's LRV ridership climbs above the pre-August 1998 trends, it is possible that additional vehicles (beyond what is described above) may be required to handle additional ridership demand on the existing Metro lines. Over the next few years, as Muni's ridership analysis and forecasting methods become more sophisticated, Muni will refine this analysis and will update the vehicle needs in this plan accordingly.

# 6. Supply of Revenue Vehicles

## A. Current Fleet

The supply of revenue vehicles is a function of several factors. The total fleet composition establishes the maximum supply of vehicles. This is then reduced according to the daily maintenance needs, and also by any vehicle maintenance programs underway.

Muni is currently transitioning the LRV fleet from a fleet of 128 Boeing Standard Light Rail Vehicles (SLRVs) manufactured between 1978 and 1984, to a near-term fleet of 151 Breda LRV-2 and LRV-3s, manufactured between 1996 and 2002. This fleet of 151 vehicles will be sufficient to operate the Third Street line and to open the New Central Subway (3-car demand), but not the additional Mission Bay service anticipated in FY14/15, or any needed capacity enhancements. Muni will need to procure additional vehicles for the Mission Bay service, and this need is currently anticipated to be 10 additional vehicles shown in FY2009. The current operating plan for the Central Subway (Phase 2 of the Third Street Project) anticipates that three (3) additional vehicles will be needed above current demand for the Central Subway. Muni does not anticipate needing to purchase additional vehicles for the Central Subway in its current configuration, as the three additional vehicles needed are being procured as part of the Third Street project. Muni does anticipate, however, that ridership growth on the existing Muni Metro system, and ridership generated by the residential and office development will create demand for additional vehicles, and this is currently planned to be 10 additional vehicles in 2015.

The HSC fleet consists of 27 active cars for regular F-line service, made up of a mixture of PCC cars and Milan cars. Muni also owns 34 other vintage and historic cars, some inactive, and some in various stages of repair. Several of these could be returned to service with minor work, although many would require major overhaul to return to service. In general, Muni considers only the PCC fleet and the fleet of Milan "Peter Witt" cars to be suitable for daily revenue service. Many of the cars in Muni's HSC fleet are considered "Special Service Cars", which means that because of maintenance and other considerations, these cars are not suitable for daily revenue service.

### B. Future Vehicle Purchases

Muni is currently under contract with Breda to complete the deliveries of LRV-3s to bring the LRV fleet to 151 vehicles. Within the 20-year timeframe of this plan, Muni anticipates needing to purchase an additional 10 LRVs to be delivered by FY08/09 for additional Mission Bay service due to ridership growth in this developing area. Muni is currently investigating accelerating the timetable for bringing the Central Subway into revenue service. One issue that will need to be resolved, if the purchase is significantly accelerated, is providing adequate storage space in Muni's current facilities, which are operating at capacity. Muni also anticipates needing an additional 10 LRVs for capacity enhancement on the existing system, to be available for service in 2015.

Muni anticipates needing to bring an additional 12 HSCs into the active fleet for everyday revenue service by FY03/04. This could be accomplished by performing major overhauls on cars already on the property, or by purchasing historic cars from a museum or other operator. These cars would also probably need major overhaul before entering revenue service.

Given the large amount of interest in San Francisco in operating historic streetcar services, it is possible that additional historic services beyond those enumerated in this plan could be planned for future years, or if ridership growth continues, additional vehicles may be required for capacity enhancement. Future updates of this plan will be revised accordingly.

## 7. LRV Fleet Plan

Muni's Fleet Plan is summarized in Figures 21 and 22 for the LRV and HSC fleets. These figures show the following for the 20-year period covered by this plan:

- Fleet composition;
- Projected peak demand figures for each year;
- Spare ratio;
- Number of new vehicles entering the fleet;

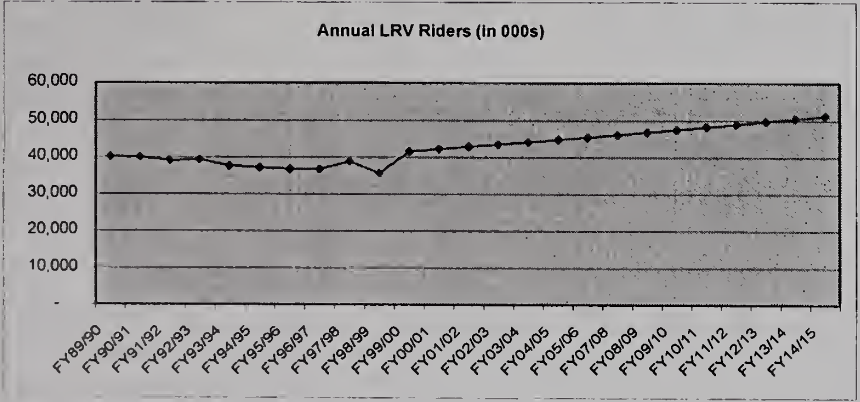
- Number of vehicles being retired from the fleet;
- Average vehicle age; and
- Fleet capacity (expressed as SCE – Standard 40' Motor Coach Equivalents)

Muni's Fleet Plan is updated every two years, when the Short Range Transit Plan (SRTP) is updated. The next update of the SRTP is scheduled for late-summer 2001.

Figure 20 - Annual LRV Ridership Projections

| | FY89/90 | FY90/91 | FY91/92 | FY92/93 | FY93/94 | FY94/95 | FY95/96 | FY96/97 | FY97/98 | FY98/99 | FY99/00 | FY00/01 | FY01/02 | FY02/03 | FY03/04 | FY04/05 | FY05/06 | FY07/08 | FY08/09 | FY09/10 | FY10/11 | FY11/12 | FY12/13 | FY13/14 | FY14/15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual LRV Riders (in 000s) | 40,214 | 40,044 | 39,034 | 39,332 | 37,615 | 37,178 | 36,728 | 36,738 | 38,898 | 35,660 | 41,610 | 42,234 | 42,868 | 43,511 | 44,163 | 44,826 | 45,498 | 46,181 | 46,873 | 47,576 | 48,290 | 49,014 | 49,750 | 50,496 | 51,253 |
| Percent Change from Prev. Year | | 0% | -3% | 1% | -4% | -1% | -1% | 0% | 6% | -8% | 17% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% | 1.5% |

*Source FY89/90 - FY99/00: National Transit Database*



**Load Factor Projections**

| Line | FY00 Actual Avg. Load Factor | FY15 Projected Load Factor without add'l vehicles | FY15 Projected Load Factor with add'l vehicles |
|---|---|---|---|
| AM Load Factors | | | |
| J | 0.76 | 0.94 | 0.74 |
| K | 0.88 | 1.08 | 0.86 |
| L | 0.88 | 1.08 | 0.86 |
| M | 0.75 | 0.92 | 0.73 |
| N | 0.95 | 1.17 | 0.93 |
| PM Load Factors | | | |
| J | 0.79 | 0.97 | 0.77 |
| K | 0.86 | 1.06 | 0.84 |
| L | 0.87 | 1.07 | 0.85 |
| M | 0.83 | 1.02 | 0.81 |
| N | 0.90 | 1.11 | 0.88 |

## Figure 21 - LRV Fleet Composition

| Fiscal Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| **Light Rail Vehicle** | | | | | | | | | | | | | | | | | | | | | |
| 1978 - Boeing (1200-1299) | 31 | 24 | | | | | | | | | | | | | | | | | | | |
| 1983 - Boeing (1300-1329) | 28 | 18 | | | | | | | | | | | | | | | | | | | |
| 1996 - Breda (1400-1476) | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 |
| 1999 - Breda (1477-1535) | | 17 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 |
| 2002 - Breda (1536-1551) | | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| 2008 - New | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 2015 - New | | | | | | | | | | | | | | | | 10 | 10 | 10 | 10 | 10 | 10 |
| Revenue Fleet | 136 | 136 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 161 | 161 | 161 | 161 | 161 | 161 | 171 | 171 | 171 | 171 | 171 | 171 |
| Peak Demand | 104 | 104 | 104 | 110 | 123 | 123 | 123 | 123 | 123 | 134 | 134 | 134 | 134 | 134 | 134 | 142 | 142 | 142 | 142 | 142 | 142 |
| Spare Ratio | 31% | 31% | 45% | 37% | 23% | 23% | 23% | 23% | 23% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| New Vehicles | - | 17 | 42 | 15 | | - | - | - | - | 10 | - | - | - | - | - | 10 | - | - | - | - | - |
| Retired Vehicles | 49 | 17 | 42 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Avg. Vehicle Age | 11 | 10 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 16 | 17 | 18 | 19 | 20 | 21 |
| SCE (Capacity) | 272 | 272 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 322 | 322 | 322 | 322 | 322 | 322 | 342 | 342 | 342 | 342 | 342 | 342 |

Notes:

1) During FY2000 and FY2001, fleet size shown is estimated size in January of each year.
2) Due to overlapping delivery and retirement schedules, actual fleet size may differ slightly from fleet shown here during periods of transition.

## Figure 22 - Historic Streetcar Fleet Composition

| Fiscal Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| **Historic Streetcar - Active Fleet - Regular Service** | | | | | | | | | | | | | | | | | | | | | |
| 1928 Milan Peter Witt | 6 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 1946 SEPTA PCC | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 1948 Muni Dbl End PCC | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 2003 - New/Rehab | | | | | 6 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Revenue Fleet | 23 | 25 | 27 | 27 | 33 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 |
| Peak Demand | 21 | 24 | 24 | 28 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| Spare Ratio | 10% | 4% | 13% | -4% | -3% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| New Vehicles | - | 2 | 2 | - | 6 | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Retired Vehicles | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| SCE (Capacity) | 46 | 50 | 54 | 54 | 66 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 |

Notes:

1) Only cars available for regular F-line operation are listed. Special Service cars, cars in storage or inactive for lengthy periods of time are not listed.
2) Special Service cars may be used on an occasional basis to fill in for Regular Service cars, especially in 2001 through 2003.

## 8. Maintenance and Reliability

### A. Vehicle Problems

Over the last few years, the reliability of Muni's LRV fleet has increased, largely due to the retirement of the most problematic of the Boeing fleet as new Breda LRV-2s have been delivered. Muni's LRV fleet has historically experienced more maintenance and reliability problems than LRV fleets at other properties. This is due to a number of factors unique to Muni:

- From 1978 to 1996, Muni's LRV fleet consisted entirely of Boeing/Vertol Standard Light Rail Vehicles (SLRVs). These cars were the first light rail cars built in the United States after a 25-year period of no light rail car construction in the US (1952-1977), and have been problematic in operation at both Muni and at MBTA (Boston), which have been the only operators of these cars. MBTA was allowed to retire their SLRV fleet early, and Muni is in the process of retiring the last of the Boeing cars now.
- Muni's LRVs employ plug doors, which have proven to have higher maintenance requirements than leaf doors.
- Muni's LRV operation has historically required frequent in-service enroute coupling and uncoupling of cars. This has contributed to problems with the couplers, which has required high levels of maintenance, and has meant that the cars have suffered frequent in-service breakdowns.
- Muni's LRVs often operate with very high load factors on steep grades. Some grades on the Muni LRV system are as steep as 9%.
- Muni has a low peak to base ratio, which means that most of Muni's LRV fleet does not pull back into the yard during the midday period. A high percentage of Muni's LRV fleet runs approximately 20 hours per day, which limits the availability for maintenance activities.

The two best indicators of vehicle reliability are car availability, which tells how many cars are available for service at the time they are supposed to pull out of the yard, and the Mean Distance Between Failures (MDBF) rate, which shows how long cars operate out on the system between breakdowns.

### B. Car Availability

Figures 23 and 24 show the availability of cars at Green Division at pull-out time in the morning. This figure indicates that Muni is consistently slightly below the target of 100% car availability for Muni Metro LRVs, but above 100% availability for PCCs and historic LRVs.

### C. Mean Distance Between Failures

Figure 25 shows the actual MDBF rate, and compares this with the target MDBF. This figure is broken down by vehicle type, showing separate figures for Boeing SLRVs, Breda LRV-2s, and PCC cars. Both SLRVs and LRV-2s are significantly below target in MDBF rate, but it is

## Figure 23 - LRV Availability

| LRV | | | | | | |
|---|---|---|---|---|---|---|
| MONTH | FLEET | FLEET SIZE | AVG. HOLDS | VEH AVAIL. | DEMAND | % AVAIL |
| Nov-99 | LRV | 136 | 37 | 99 | 101 | 98% |
| Dec-99 | LRV | 136 | 38 | 98 | 101 | 97% |
| Jan-00 | LRV | 136 | 38 | 98 | 101 | 97% |
| Feb-00 | LRV | 136 | 39 | 97 | 101 | 96% |
| Mar-00 | LRV | 136 | 39 | 97 | 101 | 96% |
| Apr-00 | LRV | 136 | 37 | 99 | 101 | 98% |
| May-00 | LRV | 136 | 35 | 101 | 101 | 100% |

*Source: Metro 30-Day Hold Analysis*

## Figure 24 - PCC/HSC Availability

| PCC/ HSC | | | | | | |
|---|---|---|---|---|---|---|
| MONTH | FLEET | FLEET SIZE | AVG. HOLDS | VEH AVAIL. | DEMAND | % AVAIL |
| Nov-99 | PCC | 17 | 2 | 15 | 13 | 115% |
| Dec-99 | PCC | 17 | 2 | 15 | 13 | 115% |
| Jan-00 | PCC | 17 | 3 | 14 | 13 | 108% |
| Feb-00 | PCC | 17 | 3 | 14 | 13 | 108% |
| Mar-00 | PCC | 22 | 4 | 18 | 17 | 106% |
| Apr-00 | PCC | 22 | 2 | 20 | 17 | 118% |
| May-00 | PCC | 32 | 8 | 24 | 17 | 141% |

*Source: Metro 30-Day Hold Analysis*

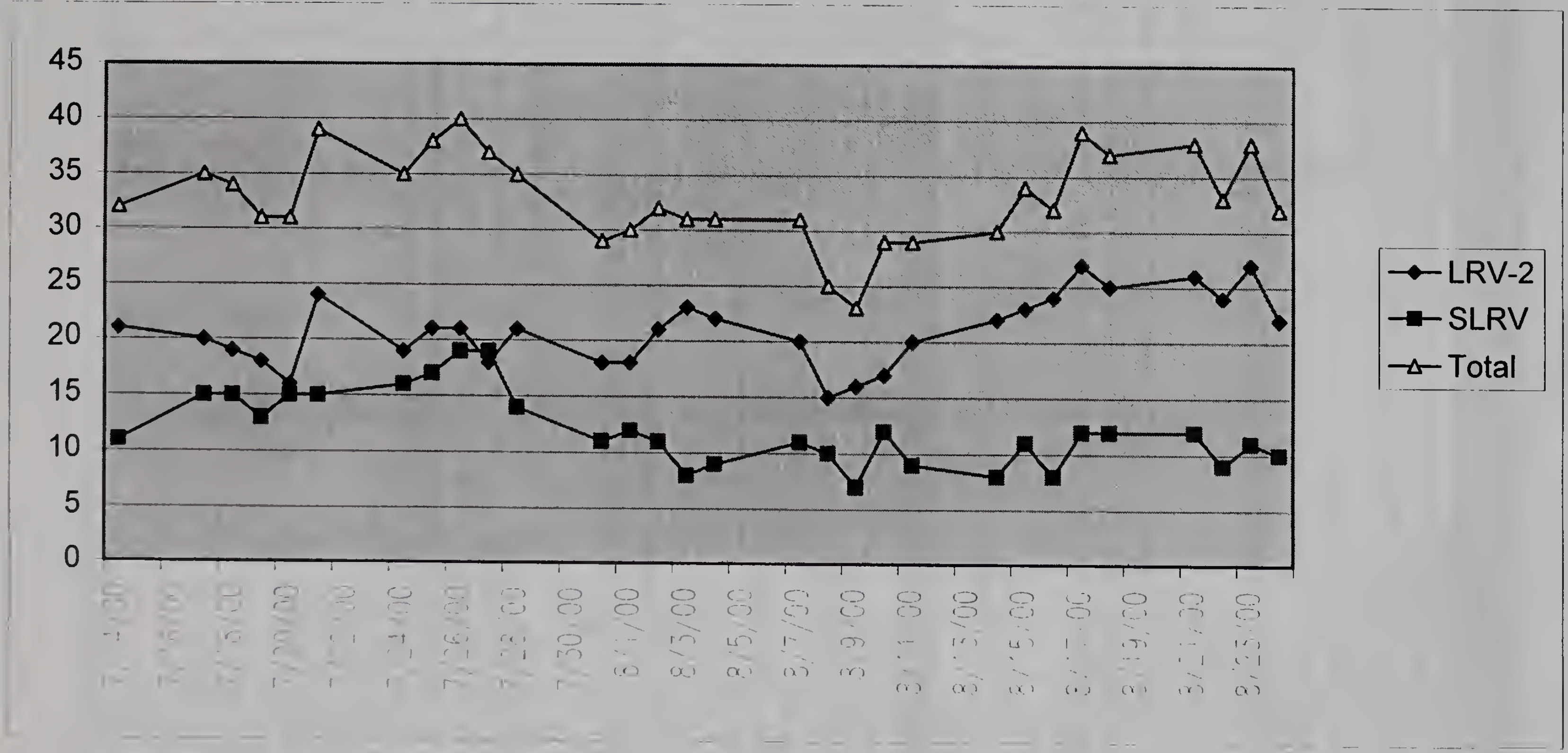
## Figure 25 - Mean Distance Between Failures

FY1999-2000

| | Boeing S L R V | | | | Breda L R V 2 | | | | P C C | | | | TOTAL LRV | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Mileage | Road-calls | MDBF | Percent of Target | Mileage | Road-calls | MDBF | Percent of Target | Mileage | Road-calls | MDBF | Percent of Target | Mileage | Road-calls | MDBF |
| Jul-99 | 100,225 | 26 | 3854.8 | 128% | 153,227 | 74 | 2071 | 69% | 31,568 | 14 | 2254.9 | 180% | 285,020 | 114 | 2500 |
| Aug-99 | 103,492 | 29 | 3568.7 | 119% | 177,601 | 81 | 2193 | 73% | 32,948 | 15 | 2196.5 | 176% | 314,041 | 125 | 2512 |
| Sep-99 | 92,892 | 37 | 2510.6 | 84% | 163,287 | 130 | 1256 | 42% | 32,687 | 25 | 1307.5 | 105% | 288,866 | 192 | 1505 |
| Oct-99 | 103,510 | 52 | 1990.6 | 66% | 154,392 | 96 | 1608 | 54% | 31,893 | 31 | 1028.8 | 82% | 289,795 | 179 | 1619 |
| Nov-99 | 107,162 | 50 | 2143.2 | 71% | 167,035 | 88 | 1898 | 63% | 33,107 | 22 | 1504.9 | 120% | 307,304 | 160 | 1921 |
| Dec-99 | 102,973 | 65 | 1584.2 | 53% | 170,222 | 72 | 2364 | 79% | 33,759 | 25 | 1350.4 | 108% | 306,954 | 162 | 1895 |
| Jan-00 | 104,223 | 47 | 2217.5 | 74% | 157,924 | 93 | 1698 | 57% | 33,253 | 19 | 1750.2 | 140% | 295,400 | 159 | 1858 |
| Feb-00 | 100,672 | 72 | 1398.2 | 47% | 131,298 | 103 | 1275 | 42% | 32,391 | 29 | 1116.9 | 89% | 264,361 | 204 | 1296 |
| Mar-00 | 103,382 | 74 | 1397.1 | 47% | 131,059 | 126 | 1040 | 35% | 48,455 | 47 | 1031 | 82% | 282,896 | 247 | 1145 |
| Apr-00 | 99,853 | 68 | 1468.4 | 49% | 171,483 | 92 | 1864 | 62% | 47,658 | 29 | 1643.4 | 131% | 318,994 | 189 | 1688 |
| May-00 | 128,700 | 80 | 1608.8 | 54% | 224,944 | 156 | 1442 | 48% | 45,068 | 29 | 1554.1 | 124% | 398,712 | 265 | 1505 |
| Jun-00 | 124,246 | 62 | 2004 | 67% | 203502 | 109 | 1867 | 62% | 40791 | 37 | 1102.5 | 88% | 368,539 | 208 | 1772 |
| YTD | 1,271,330 | 662 | 1920.4 | 64% | 2,005,974 | 1220 | 1644 | 55% | 443,578 | 322 | 1377.6 | 110% | 3,720,882 | 2204 | 1688 |
| Target | | | 3000 | | | | 3000 | | | | 1250 | | | | |
| Months At/Above Target | | | 2 | | | | 0 | | | | 8 | | | | |

Source: *Monthly Management Report*

**Figure 26 - 30-Day LRV Holds - Weekday AM Peak**
7/14/00-8/23/00



Source: *Metro 30-Day Hold Analysis*

# Figure 27 - 30-Day Hold Items

7/14/00-8/24/00

| | SLRV | Avg per vehicle | LRV-2 | Avg per vehicle |
|---|---|---|---|---|
| AIR = Air supply / compressor | 30 | 0.59 | 10 | 0.12 |
| ART = Articulation section | 0 | 0.00 | 0 | 0.00 |
| ATA = ATCS Alcatel Repair * | n/a | n/a | 0 | 0.00 |
| ATC = ATCS Muni Repair | 20 | 0.39 | 29 | 0.35 |
| AUX = AUX Inverter & Power Supply | n/a | n/a | 3 | 0.04 |
| B = Brake System | 25 | 0.49 | 21 | 0.25 |
| BAT = Battery | n/a | n/a | 0 | 0.00 |
| BOD = Internal Body Damage | 15 | 0.29 | 6 | 0.07 |
| CAB = Cab Signaling | 0 | 0.00 | n/a | n/a |
| CB = Carbody External | n/a | n/a | 29 | 0.35 |
| COM = Communications | 0 | 0.00 | 14 | 0.17 |
| COP = Coupler | 3 | 0.06 | 23 | 0.27 |
| D = Doors and Hi/Low Steps | 10 | 0.20 | 26 | 0.31 |
| DT = Diagnostic Tests | 0 | 0.00 | 0 | 0.00 |
| E = Electrical | 4 | 0.08 | 2 | 0.02 |
| F = Floors | n/a | n/a | 0 | 0.00 |
| HVC = Heating, Air Cond. | 0 | 0.00 | 94 | 1.12 |
| JB = Junction Box Assembly | n/a | n/a | 0 | 0.00 |
| L = Lighting | 3 | 0.06 | 2 | 0.02 |
| MC = Propulsion Master Controller | 0 | 0.00 | 0 | 0.00 |
| MIR = Mirror, Bracket | n/a | n/a | 1 | 0.01 |
| MIS = Miscellaneous | 0 | 0.00 | 33 | 0.39 |
| MTA = Motor Truck Assembly | 29 | 0.57 | 6 | 0.07 |
| NFM = No Forward Motion | 0 | 0.00 | n/a | n/a |
| P = Propulsion | 128 | 2.51 | 29 | 0.35 |
| PAN = Pantograph Assembly | 1 | 0.02 | 1 | 0.01 |
| PB = Pilot Bar | n/a | n/a | 1 | 0.01 |
| PBM = Propulsion Blower Motor | 0 | 0.00 | n/a | n/a |
| PEC = Prop. Elec. Control (APSE) | n/a | n/a | 0 | 0.00 |
| PM = Preventive Maintenance | 32 | 0.63 | 66 | 0.79 |
| PS =Paint Shop | 7 | 0.14 | 11 | 0.13 |
| R = Roof, Safety Cables | 0 | 0.00 | n/a | n/a |
| S = Salvage (use for parts) | 0 | 0.00 | n/a | n/a |
| SAV = SAV Bracket | n/a | n/a | 0 | 0.00 |
| SDA = Spindle Drive Assembly | n/a | n/a | 0 | 0.00 |
| SGN = Farebox & Destination Sign | n/a | n/a | 9 | 0.11 |
| SND = Sanding Hose/Nozzle | n/a | n/a | 5 | 0.06 |
| SOL = V/V Double Solenoid | n/a | n/a | 0 | 0.00 |
| STP = Hi / Low Steps | 1 | 0.02 | 15 | 0.18 |
| TA = Non-Motor Truck Assembly. | 11 | 0.22 | 52 | 0.62 |
| TM = Traction Motor | 0 | 0.00 | 0 | 0.00 |
| V = Vestibule Floor Sills | n/a | n/a | 0 | 0.00 |
| VC = Vehicle Onboard Computer | n/a | n/a | 0 | 0.00 |
| VT = Vetag Unit | n/a | n/a | 0 | 0.00 |
| W= Major Wreck | n/a | n/a | 118 | 1.40 |
| WHL = Wheel set | 8 | 0.16 | 4 | 0.05 |
| WIN = Windows | 16 | 0.31 | 17 | 0.20 |
| WP = Wipers | n/a | n/a | 1 | 0.01 |
| **Total Holds** | **343** | **6.73** | **628** | **7.48** |

*Source: Metro 30-Day Hold Analysis*

noteworthy that the Boeing SLRVs are currently operating more miles between failures than are the new Breda LRV-2s. Only the PCC fleet is consistently meeting the MDBF targets.

## D. Holds

Figure 26 shows the 30-day figures for weekday AM holds for SLRVs and LRV-2s. Figure 27 details the reasons for the holds, identifying the major problem areas for each vehicle type.
In order to improve vehicle availability and the MDBF rate, Muni has several maintenance programs in place. Muni has recently completed the Boeing Retrofit project, which is a program designed to enhance the durability of the Boeing fleet by updating the coupler and door systems on the cars remaining in the fleet.

Muni also currently has a retrofit program for the first order of Breda LRV-2s (Cars 1400-1476), for modifications to the vehicle wiring, window seal gaskets, trucks and sander tubes.

## E. Overhaul Programs

Historically, Muni has not had regular overhaul programs for rail vehicles, and this has contributed to availability and reliability problems for Muni's LRV and HSC fleets. For Muni's new Breda fleet, the overhaul needs have been preliminarily defined as the following:

**Figure 28 Breda LRV-2/3 Overhaul Needs**

| Timing | Systems |
|---|---|
| Annually | HVAC |
| 4 Years | Brakes, couplers |
| 5 Years | Pantograph, propulsion |
| 7 Years | Doors |
| 10 Years | Major Overhaul |
| 15 Years | Carbody, seats, cab |

Figure 29 provides a preliminary schedule for major overhauls (10 and 15-year overhauls) for the LRV fleet. Figure 30 provides a schedule for major overhauls for the HSC fleet.

## F. Revenue Vehicle Demand/Supply Balance

Figure 31 illustrates Muni's supply/demand balance for revenue vehicles. This figure indicates that Muni's fleet is generally appropriately sized for the currently anticipated service demands through 2020, with the current deliveries underway, and assuming the addition of 10 new LRVs in 2009 for Mission Bay and 10 new vehicles in 2015 for capacity enhancement.

## 9. Conclusion

This plan shows that Muni has an appropriate fleet size and vehicle procurement plan, given the ridership demands of the current system, the maintenance needs of the vehicles, and the anticipated growth in the system through the extension planning currently underway. This plan provides for a reasonable expansion of the fleet to handle expected ridership growth due to development, and due to the need to enhance capacity on the existing system. Growing demands on the HSC fleet due to ridership growth are likely to require expansion of that fleet.

Muni has a fleet plan that balances the need to provide vehicles for revenue service with the need to provide sufficient vehicles for maintenance needs. The coming expansion of Muni's LRV maintenance capabilities through the construction of Metro East as part of the Third Street Light Rail Line will allow Muni to improve regular maintenance activities, and to provide improved service to the public.

## Figure 29 - LRV Proposed Overhaul Schedule

| Fiscal Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| **Light Rail Vehicle** | | | | | | | | | | | | | | | | | | | | | |
| **1996 - Breda (1400-1476)** | | | | | | | | | | | | | | | | | | | | | |
| 10-Year Major Overhaul | | | | | | | 77 | | | | | | | | | | | | | | |
| 15-Year Carbody Overhaul | | | | | | | | | | | | 77 | | | | | | | | | |
| 20-Year Major Overhaul | | | | | | | | | | | | | | | | | 77 | | | | |
| **1999 - Breda (1477-1536)** | | | | | | | | | | | | | | | | | | | | | |
| 10-Year Major Overhaul | | | | | | | | | | 59 | | | | | | | | | | | |
| 15-Year Carbody Overhaul | | | | | | | | | | | | | | | 59 | | | | | | |
| 20-Year Major Overhaul | | | | | | | | | | | | | | | | | | | | 59 | |
| **2002 - Breda (1537-1552)** | | | | | | | | | | | | | | | | | | | | | |
| 10-Year Major Overhaul | | | | | | | | | | | | | 15 | | | | | | | | |
| 15-Year Carbody Overhaul | | | | | | | | | | | | | | | | | | 15 | | | |
| 20-Year Major Overhaul | | | | | | | | | | | | | | | | | | | | | |
| **2008 - New** | | | | | | | | | | | | | | | | | | | | | |
| 10-Year Major Overhaul | | | | | | | | | | | | | | | | | | | 10 | | |
| 15-Year Carbody Overhaul | | | | | | | | | | | | | | | | | | | | | |
| 20-Year Major Overhaul | | | | | | | | | | | | | | | | | | | | | |
| **LRV SUMMARY** | | | | | | | | | | | | | | | | | | | | | |
| **10-Year Major Overhaul** | - | - | - | - | - | - | 77 | - | - | 59 | - | - | 15 | - | - | - | - | - | 10 | - | - |
| **15-Year Carbody Overhaul** | - | - | - | - | - | - | - | - | - | - | - | 77 | - | - | 59 | - | - | 15 | - | - | - |
| **20-Year Major Overhaul** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 77 | - | - | 59 | - |

| Costs | Per LRV (in millions) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10-Year | $ 0.20 | $ - | $ - | $ - | $ - | $ - | $ - | $ 16 | $ - | $ - | $ 12 | $ - | $ - | $ 3 | $ - | $ - | $ - | $ - | $ - | $ 2 | $ - | $ - |
| 15-Year | $ 0.25 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ 20 | $ - | $ - | $ 15 | $ - | $ - | $ 4 | $ - | $ - | $ - |
| 20-Year | $ 0.25 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ 20 | $ - | $ - | $ 15 | $ - |
| TOTAL | | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** | **$ 16** | **$ -** | **$ -** | **$ 12** | **$ -** | **$ 20** | **$ 3** | **$ -** | **$ 15** | **$ -** | **$ 20** | **$ 4** | **$ 2** | **$ 15** | **$ -** |

## Figure 30 - Historic Streetcar Proposed Overhaul Schedule

| Fiscal Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| **Historic Light Rail Vehicles** | | | | | | | | | | | | | | | | | | | | | |
| **1928 Milan Peter Witt** | | | | | | | | | | | | | | | | | | | | | |
| Mechanical | | | 10 | | | | | | | | | | | | | | | | | | |
| Major Overhaul | | | | | | | | | | | | | 10 | | | | | | | | |
| **1946 SEPTA PCC** | | | | | | | | | | | | | | | | | | | | | |
| Body | | | 14 | | | | | | | | | | | | | | | | | | |
| Mechanical | | | | | | | | | 14 | | | | | | | | | | | | |
| Major Overhaul | | | | | | | | | | | | | | | 14 | | | | | | |
| **1948 Muni Dbl End PCC** | | | | | | | | | | | | | | | | | | | | | |
| Mechanical | | | | | | | | | 3 | | | | | | | | | | | | |
| Major Overhaul | | | | | | | | | | | | | | | 3 | | | | | | |
| **Single End PCC** | | | | | | | | | | | | | | | | | | | | | |
| Mechanical | | | | | | | | | | | | 3 | | | | | | | | | |
| Major Overhaul | | 3 | | | | | | | | | | | | | | | | | | | |
| **Special Service Cars** | | | | | | | | | | | | | | | | | | | | | |
| Mechanical | | | | | | | | | | | | | | 6 | | | | | | | |
| Major Overhaul | | | | 6 | | | | | | | | | | | | | | | | | |
| **HSCs New 2003** | | | | | | | | | | | | | | | | | | | | | |
| Mechanical | | | | | | | | | | | | | | 12 | | | | | | | |
| Major Overhaul | | | | 12 | | | | | | | | | | | | | | | | | |
| **HSC SUMMARY** | | | | | | | | | | | | | | | | | | | | | |
| **Body** | - | - | 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Mechanical** | - | - | 10 | - | - | - | - | - | 17 | - | - | 3 | - | 18 | - | - | - | - | - | - | - |
| **Major Overhaul** | - | 3 | - | 18 | - | - | - | - | - | - | - | - | 10 | - | 17 | - | - | - | - | - | - |

| Costs | Per HSC (in millions) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mechanical | $ | 0.05 | $ - | $ - | $ 1 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Body | $ | 0.05 | $ - | $ - | $ 1 | $ - | $ - | $ - | $ - | $ - | $ 1 | $ - | $ - | $ 1 | $ - | $ 1 | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Major | $ | 1.00 | $ - | $ 3 | $ - | $ 18 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ 10 | $ - | $ 17 | $ - | $ - | $ - | $ - | $ - | $ - |
| TOTAL | | | **$ -** | **$ 3** | **$ 2** | **$ 18** | **$ -** | **$ -** | **$ -** | **$ -** | **$ 1** | **$ -** | **$ -** | **$ 1** | **$ 10** | **$ 1** | **$ 17** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** |

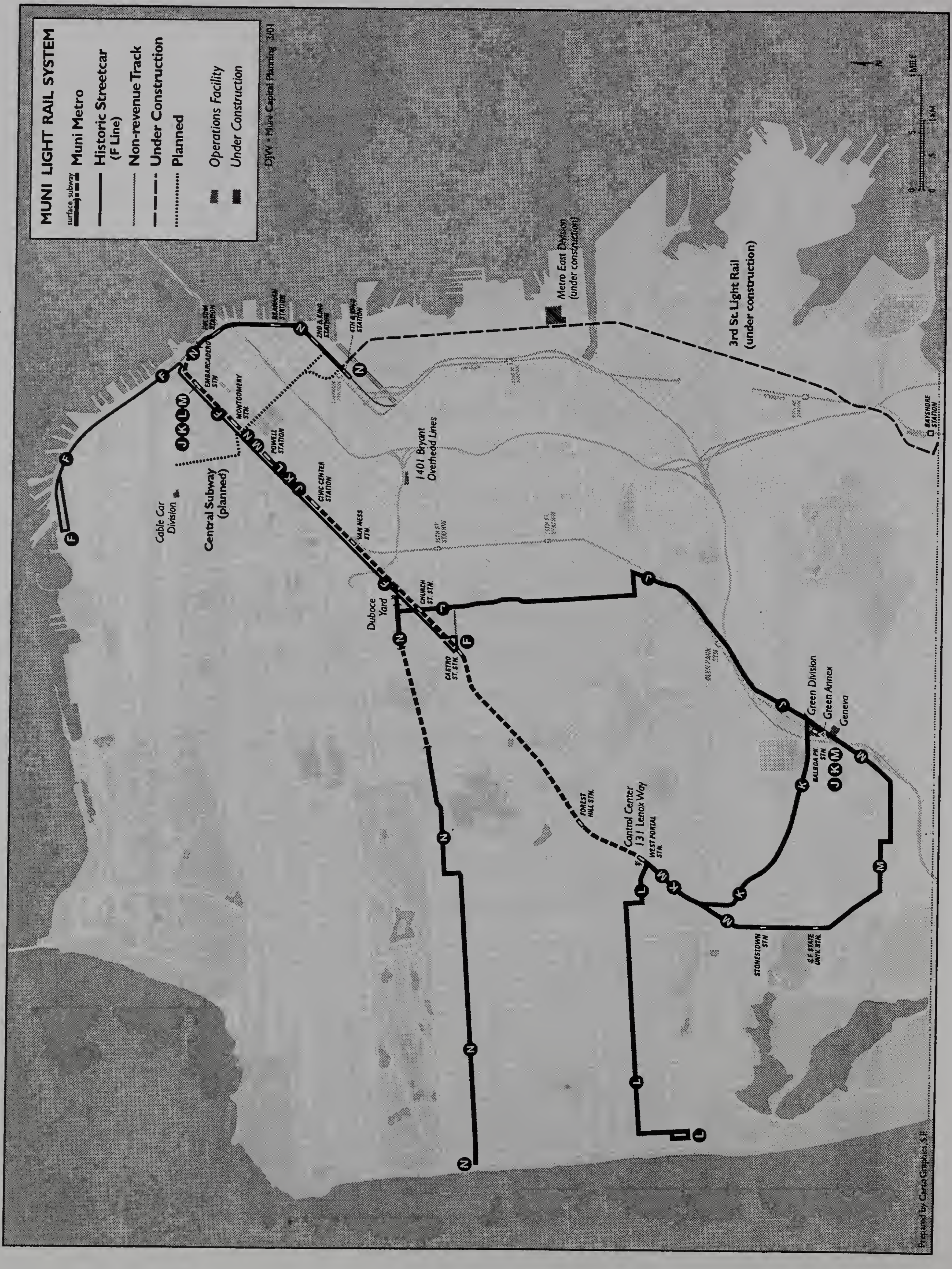
## Figure 31 - LRV Vehicle Supply/Demand Balance

| **Fiscal Year** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Light Rail Vehicle** | | | | | | | | | | | | | | | | | | | | | |
| ***Vehicle Demand*** | | | | | | | | | | | | | | | | | | | | | |
| Peak Vehicle Demand | 104 | 104 | 104 | 110 | 123 | 123 | 123 | 123 | 123 | 134 | 134 | 134 | 134 | 134 | 134 | 142 | 142 | 142 | 142 | 142 | 142 |
| Maintenance Demand | | | | | | | | | | | | | | | | | | | | | |
| Body Work/Paint Shop | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PM & Fault Clearing | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| PM Diagnostic Test | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Running Repair | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Heavy Repair/Support Shops | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Retrofit Campaigns | 2 | 8 | 8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| ATCS | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Miscellaneous | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Vendor/Manufacturer | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Overhaul | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Total Maintenance | 27 | 33 | 33 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| **TOTAL VEHICLE DEMAND** | **131** | **137** | **137** | **139** | **152** | **152** | **152** | **152** | **152** | **163** | **163** | **163** | **163** | **163** | **163** | **171** | **171** | **171** | **171** | **171** | **171** |
| | | | | | | | | | | | | | | | | | | | | | |
| ***Vehicle Supply*** | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL VEHICLE SUPPLY** | **136** | **136** | **151** | **151** | **151** | **151** | **151** | **151** | **151** | **161** | **161** | **161** | **161** | **161** | **161** | **171** | **171** | **171** | **171** | **171** | **171** |
| | | | | | | | | | | | | | | | | | | | | | |
| ***Supply/Demand Balance*** | **5** | **-1** | **14** | **12** | **-1** | **-1** | **-1** | **-1** | **-1** | **-2** | **-2** | **-2** | **-2** | **-2** | **-2** | **0** | **0** | **0** | **0** | **0** | **0** |
| | | | | | | | | | | | | | | | | | | | | | |
| Supply/Demand Spare Ratio | 4% | -1% | 10% | 9% | -1% | -1% | -1% | -1% | -1% | -1% | -1% | -1% | -1% | -1% | -1% | 0% | 0% | 0% | 0% | 0% | 0% |
| Operating Spare Ratio | 31% | 31% | 45% | 37% | 23% | 23% | 23% | 23% | 23% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |

Notes: 1) There are no maintenance demand goals for the HSC/PCC fleet. The Supply/Demand Balance is therefore assumed to be the same as the spare ratio, as shown on Figure 20.

2) Estimates of maintenance demand based on information from Muni management.

# Appendix A


MUNI LIGHT RAIL SYSTEM
surface subway
Muni Metro
Historic Streetcar (F Line)
Non-revenue Track
Under Construction
Planned
Operations Facility
Under Construction
DJW • Muni Capital Planning 3/01
Cable Car Division
Central Subway (planned)
EMBARCADERO STN
MONTGOMERY STN
POWELL STATION
CIVIC CENTER STATION
VAN NESS STN.
CHURCH ST. STN.
CASTRO ST. STN.
FOREST HILL STN.
WEST PORTAL STN.
Duboce Yard
1401 Bryant Overhead Lines
Metro East Division (under construction)
3rd St Light Rail (under construction)
BAYSHORE STATION
BRANNAN STATION
FOLSOM STATION
2ND & KING STATION
4TH & KING STATION
Control Center 131 Lenox Way
Green Division
Green Annex
Geneva
BALBOA PK. STN.
STONESTOWN STN.
S.F. STATE UNIV. STN.
J K L M N F
1 MILE
1 KM
N
Prepared by Carto Graphics SF

## Appendix B - Light Rail Vehicle Roster

August 24, 2000

| Car No(s). | Number | Year | Manufacturer | Model | Comments |
|---|---|---|---|---|---|
| 1200 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1204 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1206 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1214-1216 | 3 | 1978-80 | Boeing/Vertol | SLRV | |
| 1219-1221 | 3 | 1978-80 | Boeing/Vertol | SLRV | |
| 1224 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1226 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1234 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1236 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1242 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1245 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1248-1249 | 2 | 1978-80 | Boeing/Vertol | SLRV | |
| 1251 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1254 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1257-1258 | 2 | 1978-80 | Boeing/Vertol | SLRV | |
| 1260 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1264-1265 | 2 | 1978-80 | Boeing/Vertol | SLRV | |
| 1268 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1272 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1275 | 1 | 1978-80 | Boeing/Vertol | SLRV | |
| 1301-1303 | 3 | 1983-84 | Boeing/Vertol | SLRV | former MBTA |
| 1305-1309 | 5 | 1983-84 | Boeing/Vertol | SLRV | former MBTA |
| 1311-1314 | 4 | 1983-84 | Boeing/Vertol | SLRV | former MBTA |
| 1316-1317 | 2 | 1983-84 | Boeing/Vertol | SLRV | former MBTA |
| 1319-1321 | 3 | 1983-84 | Boeing/Vertol | SLRV | former MBTA |
| 1323-1329 | 7 | 1983-84 | Boeing/Vertol | SLRV | former MBTA |
| **Boeing Subtotal** | **51** | | | | |
| 1400-1476 | 77 | 1996 | Breda | LRV-2 | |
| 1477-1484 | 8 | 1999 | Breda | LRV-3 | |
| **Breda Subtotal** | **85** | | | | |
| TOTAL | 136 | | | | |

## Appendix C - Historic Streetcar Roster - August 2000

| Car No. | Year | Manufacturer | Origin/Description | Operational | Last Rehab | Next Rehab | Category |
|---|---|---|---|---|---|---|---|
| **Single Ended Cars - Active Fleet (25 cars)** | | | | | | | |
| 1515 | 1928 | Accaio | Milan - purchased 1998 | Y | 2000 | | Regular Service |
| 1556 | 1928 | Accaio | Milan - purchased 1998 | Y | 2000 | | Regular Service |
| 1588 | 1928 | Accaio | Milan - purchased 1998 | N | 2000 | | Regular Service |
| 1793 | 1928 | Accaio | Milan - purchased 1998 | Y | 2000 | | Regular Service |
| 1795 | 1928 | Accaio | Milan - purchased 1998 | Y | 2000 | | Regular Service |
| 1814 | 1928 | Accaio | Milan - purchased 1998 | N | 2000 | | Regular Service |
| 1818 | 1928 | Accaio | Milan - purchased 1998 | Y | 2000 | | Regular Service |
| 1834 | 1928 | Accaio | Milan - purchased 1984 | Y | 2001 | | Regular Service |
| 1859 | 1928 | Accaio | Milan - purchased 1998 | Y | 2000 | | Regular Service |
| 1911 | 1928 | Accaio | Milan - purchased 1998 | Y | 2000 | | Regular Service |
| 1050 | 1946 | St. Louis Car | PCC, former SEPTA, Muni wings scheme | Y | 1994 | 2009 | Regular Service |
| 1051 | 1946 | St. Louis Car | PCC, former SEPTA, Muni simplified | Y | 1994 | 2009 | Regular Service |
| 1052 | 1946 | St. Louis Car | PCC, former SEPTA, LA Rwy scheme | Y | 1994 | 2009 | Regular Service |
| 1053 | 1946 | St. Louis Car | PCC, former SEPTA, Brooklyn scheme | Y | 1994 | 2009 | Regular Service |
| 1054 | 1946 | St. Louis Car | PCC, former SEPTA, PTC silver/cream | Y | 1994 | 2009 | Regular Service |
| 1055 | 1946 | St. Louis Car | PCC, former SEPTA, PTC green/cream | Y | 1994 | 2009 | Regular Service |
| 1056 | 1946 | St. Louis Car | PCC, former SEPTA, Kansas City scheme | Y | 1994 | 2009 | Regular Service |
| 1057 | 1946 | St. Louis Car | PCC, former SEPTA, Cincinnati scheme | Y | 1994 | 2009 | Regular Service |
| 1058 | 1946 | St. Louis Car | PCC, former SEPTA, CTA scheme | Y | 1994 | 2009 | Regular Service |
| 1059 | 1946 | St. Louis Car | PCC, former SEPTA, Boston Elevated scheme | Y | 1994 | 2009 | Regular Service |
| 1060 | 1946 | St. Louis Car | PCC, former SEPTA, Newark PSCT scheme | Y | 1994 | 2009 | Regular Service |
| 1061 | 1946 | St. Louis Car | PCC, former SEPTA, PE Rwy scheme | Y | 1994 | 2009 | Regular Service |
| 1062 | 1946 | St. Louis Car | PCC, former SEPTA, Louisville scheme | Y | 1994 | 2009 | Regular Service |
| 1063 | 1946 | St. Louis Car | PCC, former SEPTA, Baltimore scheme | Y | 1994 | 2009 | Regular Service |
| 1704 | 1946 | St. Louis Car | PCC, St. Louis | Y | | 2001 | Special Service |
| **Double-Ended Cars - Active Fleet (9 cars)** | | | | | | | |
| 578 | 1895 | John Hammond | Market St Rwy (2-person operation) | Y | | | Special Service |
| 1 | 1912 | W.L. Holman | Muni's first car (2-person operation) | Y | | 2002 | Special Service |
| 130 | 1914 | Jewett Car Co. | Muni (2-person operation) | Y | | 2002 | Special Service |
| 952 | 1923 | Perley A. Thomas | New Orleans (2-person operation) | Y | | | Special Service |
| 496 | 1930 | Melbourne | Melbourne semi-convertible (2-person operation) | Y | | | Special Service |
| 228 | 1934 | English Electric | Blackpool "Boat" - open car (2-person operation) | Y | | 2002 | Special Service |
| 1007 | 1948 | St. Louis Car | PCC - double ended, Red Arrow scheme | Y | 1994 | 2009 | Regular Service |
| 1010 | 1948 | St. Louis Car | PCC - double ended, Muni blue/yellow | Y | 1994 | 2009 | Regular Service |
| 1015 | 1948 | St. Louis Car | PCC - double ended, Illinois Term scheme | Y | 1994 | 2009 | Regular Service |
| **Single Ended Cars - Non-Active Fleet (17 cars)** | | | | | | | |
| 106 | 1922 | Colanna | Moscow/Orel, Russia (2-person operation) | N | | | Duboce Yard |
| 1507 | 1928 | Accaio | Milan - purchased 1998 (Parts Car) | N | | 2000 | Parts - Upper Yard |
| 1975 | 1928 | Accaio | Milan (stored inside Pier 72) (Parts Car) | N | | | Parts - Pier 72 |
| 1105 | 1946 | St. Louis Car | PCC (stored inside Pier 72) | N | | | Storage Pier 72 (Inside) |
| 1109 | 1946 | St. Louis Car | PCC (stored inside Pier 72) | N | | | Storage Pier 72 (Inside) |
| 1115 | 1946 | St. Louis Car | PCC (stored inside Pier 72) | N | | | Storage Pier 72 (Inside) |
| 1128 | 1946 | St. Louis Car | PCC (stored outside Pier 72) | N | | | Storage Pier 72 (Outside) |
| 1139 | 1946 | St. Louis Car | PCC (stored inside Pier 72) | N | | | Storage Pier 72 (Inside) |
| 1155 | 1946 | St. Louis Car | PCC (stored inside Pier 72) | N | | | Storage Pier 72 (Inside) |
| 1168 | 1946 | St. Louis Car | PCC (stored inside Pier 72) | N | | | Storage Pier 72 (Inside) |
| 2133 | 1946 | St. Louis Car | PCC, SEPTA | N | | | Duboce Yard |
| 2147 | 1946 | St. Louis Car | PCC, SEPTA (stored inside Pier 72) | N | | | Storage Pier 72 (Inside) |
| 1023 | 1951 | St. Louis Car | PCC (stored outside Pier 72) | N | | | Storage Pier 72 (Outside) |
| 1025 | 1951 | St. Louis Car | PCC (stored outside Pier 72) | N | | | Storage Pier 72 (Outside) |
| 1038 | 1951 | St. Louis Car | PCC (stored outside Pier 72) | N | | | Storage Pier 72 (Outside) |
| 3557 | 1951 | LHB | Hamburg | N | | 2002 | Storage Pier 80 |
| 1040 | 1952 | St. Louis Car | PCC, Muni (last PCC built in US) | N | | 2001 | Storage Pier 80 |
| **Double-Ended Cars - Non-Active Fleet (10 cars)** | | | | | | | |
| 189 | 1912 | J.G. Brill Co. | Oporto, Portugal open car (2-person operation) | N | | 2002 | Storage Pier 80 |
| 798 | 1924 | Market St Rwy | Muni (2-person operation) | N | | | Storage Pier 80 |
| 351 | 1926 | St. Louis Car | Johnstown PA (2-person operation) | N | | | Storage Pier 80 |
| 151 | 1927 | Kawasaki | Hankei/Osaka (2-person operation) | N | | | Storage Pier 80 |
| 578J | 1927 | Fuginagata | Kobe/Hiroshima (2-person operation) | N | | | Duboce Yard |
| 586 | 1930 | Melbourne | Melbourne semi-convertible (2-person operation) | N | | | Storage Pier 80 |
| 96 | 1931 | Milan | Milan Interurban | N | | | Storage Pier 80 |
| 1006 | 1948 | St. Louis Car | PCC - Muni - double ended | N | | 2001 | Storage Pier 80 |
| 1009 | 1948 | St. Louis Car | PCC - Muni - double ended (stored outside Pier 72) | N | | 2001 | Storage Pier 72 (Outside) |
| 1011 | 1948 | St. Louis Car | PCC - Muni - double ended (stored inside Pier 72) | N | | 2001 | Storage Pier 72 (Inside) |
| **Work Cars (3 cars)** | | | | | | | |
| 0304 | 1907 | United Railroads of SF | Line Car | Y | | | Work Car |
| C-1 | 1917 | Municipal Railway | Flatbed Work Motor | Y | | | Work Car |
| 1008 | 1948 | St. Louis Car | PCC - Muni - double ended | Y | | 2001 | Work Car |

## Acknowledgments

The preparation of this plan has involved the time and experience of a large number of individuals throughout Muni and at other organizations. We would like to thank the following individuals for their assistance:

Grenville Berliner
Susan Chelone
Luz Cofresí-Howe
Brian Cunningham
John Fong
Nathan Grief
Jack Hieda
Ben Holland
Darton Ito
Karl Johnson
Vince Lee
David Makofsky
Ron Niewiarowski
Sue Olive
Bob Olson
Pacifico Paculba
Dan Rosen
John Sadorra
Peter Straus

This document prepared by:

| | |
|---|---|
| Duncan Watry, Capital Planning & Grants | (415) 934-3937 |
| Anne Richman, Capital Planning & Grants | (415) 934-3946 |

1145 Market Street, 3rd Floor, San Francisco, CA 94103-1547